

An Industry Study on Electric Vehicle Adoption in Hong Kong



HKPC[®]

Hong Kong
Productivity Council
香港生產力促進局

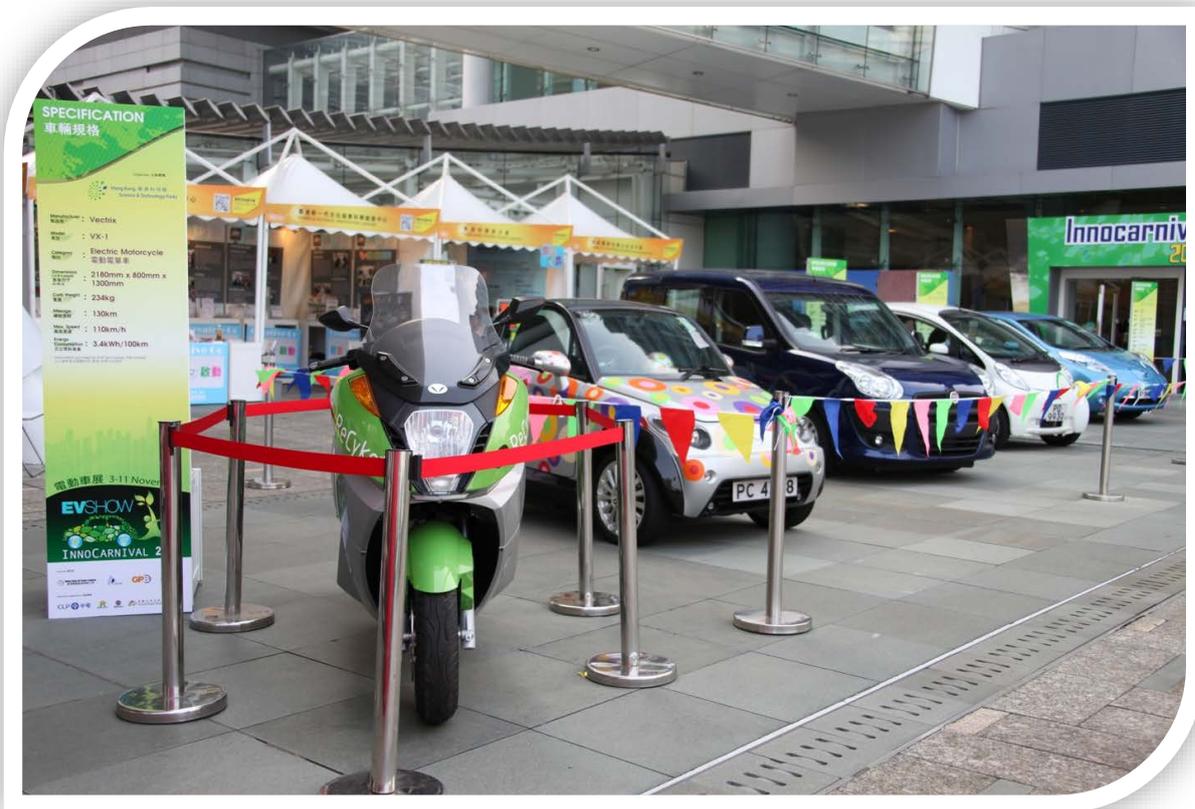
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EXECUTIVE SUMMARY



BACKGROUND

This report aims to present the findings and recommendations of a study on the promotion of Electric Vehicle (EV) adoption in Hong Kong. The study was conducted by the Hong Kong Productivity Council (HKPC), an industry support organisation and the host organisation for the Automotive Parts and Accessory Systems Research and Development Centre in Hong Kong.

Similar to on-going initiatives in many countries around the world, the promotion of EV adoption is a major environmental initiative of the Government of the Hong Kong Special Administrative Region (HKSAR), designed to improve Hong Kong's air quality. However, the growing prevalence of EVs in Hong Kong has revealed that the business model, consumer usage behaviour, EV charging infrastructure, type approval and training for repair and other support personnel are all significantly different from the processes and procedures that currently exist for gasoline-based cars.

On 28 June 2013, the HKPC organised an Industry Network Cluster (INC) consultation on green mobility to solicit views from various stakeholders. The industry was found to be facing a number of issues that could significantly stifle the growth of the local EV industry and the wider adoption of EVs by Hong Kong citizens.

OBJECTIVE

This study aims to identify and recommend key developments and ways to support higher rates of EV adoption in Hong Kong

METHODOLOGY

First, studies on the experiences of major countries regarding EV adoption strategies and their development and support by the relevant governments are discussed.

Local surveys which studied local industry views, concerns and expectations regarding EV adoption are then examined.

Five areas in the local EV "ecosystem" are identified and discussed, each of which plays a key role in reducing barriers to the adoption of EVs. These five areas are:

1. The overall government role in promoting EV adoption;
2. The EV charging infrastructure set up;
3. Human capital development in EV maintenance and support;
4. Update of the type approval regime;
5. The disposal of hazardous materials relating to EVs, particularly batteries.

A number of recommendations to various stakeholders regarding the issues identified in the five key areas are then made.

KEY FINDINGS

Studies on the overseas experiences of EV adoption have made the following key findings:

1. The adoption of EVs in other countries is mainly coordinated, promoted and supported by their respective governments.
2. Government support for the adoption of private EVs mainly comes in the form of infrastructure – such as EV charging stations set up with funding from governments.
3. In terms of EV adoption by commercial fleet operators, some governments set up and support special programmes

with the relevant industries for the trial use of EVs in their operations.

In surveys conducted with local commercial operators, the study finds that they have the following concerns:

1. **Long charging cycle** – local operators cannot afford to charge EVs during the hours when their fleets are in operation.
2. **Cost** – the costs of repair and maintenance of EVs and the charging infrastructure are uncertain.
3. **Reliability of EVs** – the lack of reliability of EVs can affect revenue.
4. **EV batteries** – the lifespan and cost of EV batteries and their disposal method is uncertain.
5. **Lack of sufficient qualified EV maintenance personnel** – there are currently no “qualified street mechanics” for EVs – this may drive maintenance costs higher.

RECOMMENDATIONS

This study makes thirteen recommendations to the HKSAR Government, supporting organisations, OEMs and service providers in the following five key areas.

Overall Government Role in Promoting EV Adoption

Recommendation 1.

Strengthen and target Government incentives in a holistic and coordinated manner

It is recommended that the HKSAR Government strengthens the subsidies and incentive schemes. This will facilitate higher EV adoption in a more targeted and coordinated manner. A neutral and non-commercial body can be set up to

holistically coordinate the promotion and development of the EV industry in Hong Kong.

EV Charging Infrastructure

Recommendation 2.

Create a common set of standards for all levels of Electric Vehicle Supply Equipment (EVSE) in Hong Kong

To promote the wider adoption of private EVs, it is recommended that the HKSAR Government consider defining the charging standards for all levels of EVSE (charging stations) and making these charging standards a part of the type approval processes.

Recommendation 3.

Migrate EVSE infrastructure to semi-quick and quick charging

The HKSAR Government and EVSE operators are recommended to consider migrating existing slow charging Level 1 standard EVSE to semi-quick and quick charging equipment to cater for new-generation EVs.

Recommendation 4.

Set up a centralised database of EV charging points

A centralised database of available EVSE can be set up and maintained, either by the Government or a neutral third party, to provide information to EV drivers on EVSE locations and status.

Recommendation 5.

Develop a viable business model for electricity supply for EVSE services

This study recommends that EVSE service providers develop a sustainable business model with property developers, property management companies and power companies. If needed, the Government can play a role in helping these players work together in mutually-beneficial arrangements.

Recommendation 6.

Install power load management systems in existing car parks

It is recommended that EVSE operators and property management companies investigate the use of intelligent electricity load management systems in order to meet the overall demand for extra EVSE without needing to increase electricity supply loading in existing car parks.

Recommendation 7.

Install more EVSE in private residential buildings and commercial sites with Government support

The HKSAR Government is recommended to consider augmenting its support for EVSE setup in residential buildings and power supply infrastructure at commercial sites. This support may be achieved through the extension of the Green Transport Fund to cover the setup costs of EVSE.

Human Capital Development

Recommendation 8.

Update the Qualifications Framework (QF) for EV training

Given the rapid advances and changing technology involved in EVs and their accessories, this study recommends that educational institutions and the automotive industry examine what needs to be added

to the QF curriculum to prepare for the increasing demand for EV services.

Recommendation 9.

Develop new training programmes for EV/EVSE maintenance and services

Training institutes such as the VTC and HKPC are recommended to look into developing new training courses for EV/EVSE maintenance and services on different models of EVs, making reference to the Qualifications Framework programme.

Type Approval

Recommendation 10.

Update type approval standards once a year

The HKSAR Government is recommended to review and update the type approval requirements of EVs more frequently, due to the changing nature of EV technology.

Safe Disposal

Recommendation 11.

Provide incentives to the battery recycling industry

It is recommended that the HKSAR Government provide support and incentives to the recycling industry in the initial stages of EV adoption. This will help trigger the start of an EV part and battery recycling industry in Hong Kong.

Recommendation 12.

Demand battery disposal plans and monitoring reports from OEMs

This study recommends that the HKSAR Government make it mandatory for all EV carmakers and importers in Hong Kong to

provide a battery disposal and monitoring plan during the type approval application process. The carmakers should be made responsible for the recording, tracking, collecting and ultimately the recycling of the EV batteries in their cars.

Recommendation 13.

Explore ways to extract valuable materials from waste EV batteries

The HKSAR Government is recommended to provide R&D funding to explore ways to safely extract valuable materials from end-of-life EV batteries, including cobalt, aluminium, nickel, copper, lithium and other materials.

Chapter 1

Problem Definition and Study Methodology



1.1. The Problem of Motor Vehicle Emissions

According to the 2012 Hong Kong Emission Inventory Report, the Road Transport sector was the largest source of air pollution in Hong Kong in 2012, responsible for producing 84,570 tonnes of air pollutants. The sector accounted for about 27 percent of Nitrogen Oxides (NO_x), 20 percent of Respirable Suspended Particulates (RSPs), 23 percent of Fine Suspended Particles (FSPs), 23 percent of Volatile Organic Compounds (VOCs) and 65 percent of Carbon Monoxide (CO) emissions. Table 1-1 shows the emission inventory for 2012 and the different emission source categories.¹

From the table, it is evident that road transport is the main cause of roadside air pollution in Hong Kong. According to Environmental Protection Department (EPD) statistics², there has been an increase in the number of days when the roadside air

pollution index (API) has reached the “very high” level (when the API exceeds 100) in recent years.³ For details, please refer to Figure 1-1.

Air pollution is becoming an increasingly serious health threat to Hong Kong citizens, and has recently aroused much public concern. Our society undeniably needs a more environmental-friendly transportation method which will reduce air pollution and lead us towards sustainability. The use of Electrical Vehicles (EVs) – which have an air pollutant emission level of zero, has emerged as the most promising alternative transportation method.

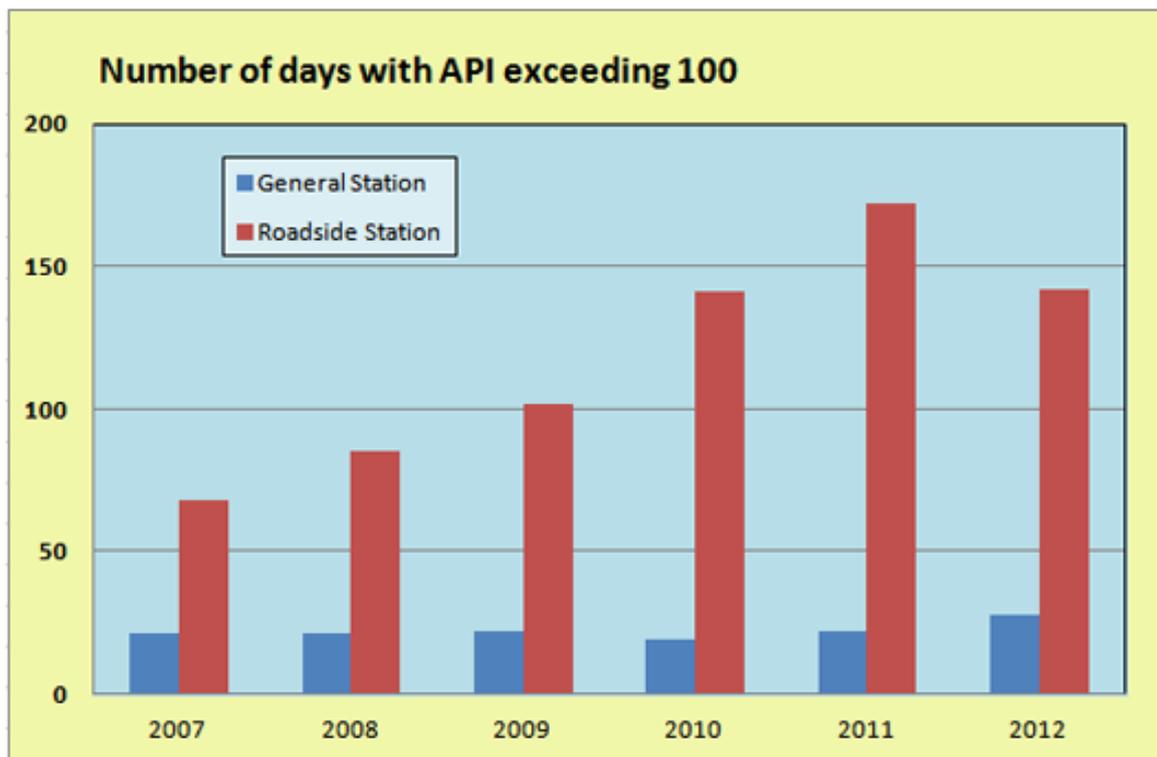
Table 1-1 Breakdown of 2012 Emission Inventory

Pollution Sources	SO ₂	NO _x	RSP	FSP	VOC	CO	Total
Public Electricity Generation	15,500	32,000	960	448	442	3,890	53,240
Road Transport	50	30,700	1,200	1,100	7,420	44,100	84,570
Navigation	16,500	36,500	2,250	2,080	3,480	11,800	72,610
Civil Aviation	510	5,870	61	61	563	3,060	10,125
Other Fuel Combustion	190	9,410	723	667	917	5,410	17,317
Non-combustion	N/A	N/A	939	479	19,400	N/A	20,818
Total Emissions (Tonnes)	32,750	114,480	6,133	4,835	32,222	68,260	258,680

¹Air Science Group, Environmental Protection Department, HKSAR, “2012 Hong Kong Emission Inventory Report”, March 2014, available at <http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2012HKEIReport_eng.pdf>

²Environmental Protection Department, HKSAR, 2014, available at <http://www.epd.gov.hk/epd/english/environmentinhk/air/air_maincontent.html>

³The EPD has launched the Air Quality Health Index (AQHI) to replace the Air Pollution Index (API) since 30 December 2013 to provide more timely and useful air pollution information to the public.



Environmental Protection Department, 2013

Figure 1-1 Yearly trend of the number of days when the API exceeds 100 (2007 to 2012)
(Remark: API has been replaced by the Air Quality Health Index since 30 December 2013)

1.2. Current EV Adoption in Hong Kong is Still Growing

According to statistics from the Transport Department, as of the end of August 2014, the total number of registered EVs in Hong Kong was 782. This accounts for just 0.1 percent of the total number of registered vehicles in Hong Kong. The number of EVs broken down by vehicle type as of August 2014⁴ is shown in Table 1-2.

As a result of the Pilot Green Transport Fund set up by HKSAR Government in 2010, which encourages the application of green technologies in the public transport sector and in goods vehicles, many companies have already begun introducing EVs into their commercial fleets. For example, Federal Express uses 10 electric vans for its courier services, of which three vans are subsidised by the Pilot Green Transport Fund. International Trademart Company Limited has introduced two electric buses, also subsidised by this fund, for the Kowloon Bay International Trade and Exhibition Centre (KITEC) and the MTR Kowloon Bay Station

shuttle services.

Table 1-2 shows that the number of EVs registered in Hong Kong is dominated by private EVs. However, as shown in the next section, the key “culprit” in roadside air pollution is the commercial fleet – accounting for 90 percent of air pollutants emitted. Therefore, it is imperative that the Government consider spending more effort on increasing the adoption rate of EVs in commercial fleets to reduce exhaust emissions.

1.3. Targeting Commercial Fleets to Encourage the Adoption of EVs

Referring to the “A Clean Air Plan for Hong Kong”, jointly published by the Bureaux of Environment, Transport and Housing, Food and Health, and Development in March 2013, 90 percent of air pollution was generated by commercial fleets. As such, these vehicles are key contributors to roadside air pollution in urban areas.

Table 1-2: Table showing different types of registered EVs (as of August 2014)

Vehicle Type	Number
Motorcycles	45
Private Cars	515
Taxis	48
Private Buses	4
Private Light Buses	4
Other non-franchised public buses	2
Light Goods Vehicles	50
Medium Goods Vehicles	2
Special purpose vehicles	112
Total number of registered EVs	782

⁴ The latest figures are of August 2014.

While commercial fleets are key contributors to roadside air pollution, they are also “low-hanging fruit”, and a highly cost-effective way of encouraging the adoption of EVs.

Commercial fleets are groups of vehicles owned or leased by a business agency for commercial use. Typical examples are taxis and public buses. Many enterprises purchase or hire vehicles to deliver goods or services to customers.

Furthermore, the operational characteristics of commercial fleets make them even more effective when promoting EV adoption:

1. Most commercial fleets have a centralised parking location. The electric vehicle supply equipment (EVSE), or charging stations, can be set up in a centralised location for easy management and maintenance. This means the cost of setting up electricity infrastructure will also be more cost effective.
2. For the reasons of cost effectiveness, commercial fleets will mostly adopt similar models of vehicles in their fleets. Similarly, when adopting EVs into their fleets, identical charging stations can be set up – for example, a medium speed charging station can serve an entire commercial fleet.
3. Most commercial fleets have regular, predictable routes. Thus, it is easier for them to plan their EV charging schedules, thus mitigating the risk of having a battery expire.

1.4. Other Means of Emissions Reduction in Commercial Fleets

For reasons of cost, fleet operators may not be able to replace all their vehicles at the

same time, even if the technology is available on the market. Retrofitting their vehicles with an “automatic idle stop system” or electric air conditioning system are cost-effective intermediate solutions for fuel saving and roadside emissions reduction. Mature solutions have been developed for taxis and light vans, with trial run starting in 2012. These solutions provide a viable option for local fleet operators to achieve “green mobility” in a cost-effective way.

1.5. Encouraging the Adoption of Private EVs

Today, the number of privately-owned EVs is steadily rising. With the introduction of more attractive and longer-range models such as the Tesla Model S, consumers are beginning to seriously consider switching to EVs, for reasons of environmental awareness, wanting to portray a “trendy” image and cost saving. The promotion of private EVs is mostly carried out by car vendors in a very similar manner to gasoline-powered cars.

However, unlike gasoline-powered cars, one of the key reservations consumers have when switching to an EV is a concern about where they can charge their EV. Unlike EV owners in the west, who can set up an EV charging point in the garage of their own home, the vast majority of Hong Kong EV owners have to park their cars at a multi-storey car park. They do not have the option of setting up a charging point at their parking bays – these are generally managed by a property management company. Instead, they are obliged to charge their EVs at public charging points in public car parks or shopping centres. To encourage the wider adoption of private EVs, this report will study what other countries are doing in this respect, with particular focus on the role of

Government in setting up EV charging stations and what incentives are given to the public.

1.6. Methodology of the Study

Conducting international surveys and collecting local views

This study carried out desktop research and relevant market surveys of EV adoption in major economies and countries around the world.

The government policies of other major countries regarding the promotion of EV adoption were also reviewed in this report. The aim of this is to provide a holistic view on good practices being implemented overseas, and to identify specific needs in Hong Kong that will help the city achieve green mobility through the adoption of EVs in major sectors.

The research was followed by interviews and surveys with major local stakeholders including Government departments and bureaux, educational institutions, commercial fleet operators, property developers and management offices to collect their views on and concerns about EV adoption.

Providing information to form a holistic plan

With the growing prevalence of EVs, it is evident from overseas experience that the business model, consumer usage behaviour, EV charging infrastructure, type approval and training of repair and other support personnel will all be very different from similar existing processes for gasoline-based cars. It is therefore – as is the case in other countries around the world – important to

holistically plan for and support Hong Kong's readiness for EV adoption.

HKPC, as an industry support organisation and the host organisation for the Automotive Parts and Accessory Systems R&D Centre in Hong Kong, aims to gain a better understanding of the underlying issues of EV adoption in Hong Kong. With this in mind, HKPC organised an Industry Network Cluster (INC) consultation on Green Mobility in June 2013 to solicit views from various stakeholders. HKPC found that the industry is currently facing a number of issues that could significantly stifle the growth of both the local EV industry and the wider adoption of EVs by citizens. These issues were broadly related to the installation costs and location of the EV charging infrastructure, the type approval testing and standards to be adopted, the fact that regulations were originally conceived for gasoline vehicles and the short supply of qualified EV maintenance personnel, to name a few.

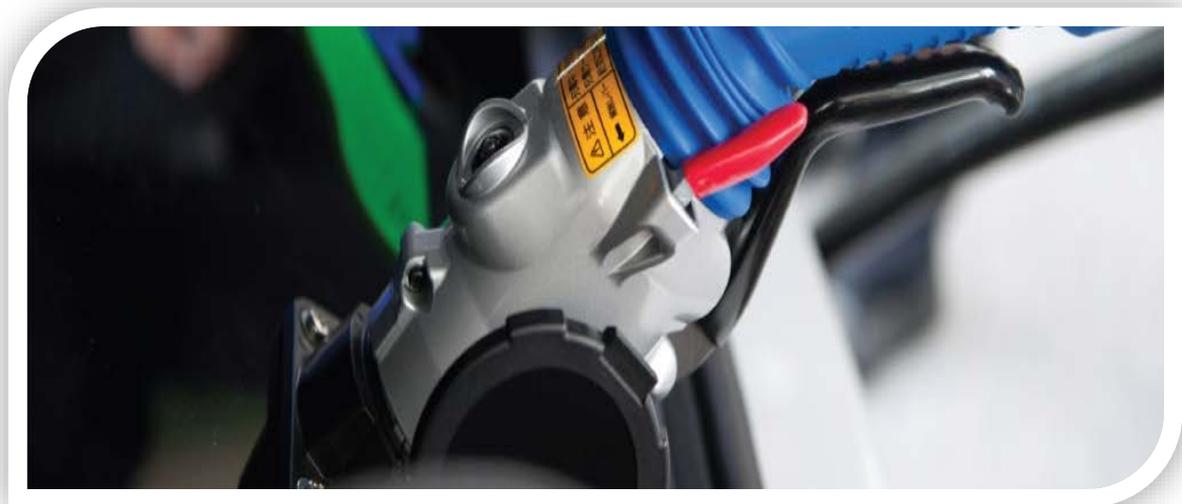
Identifying five key areas in EV adoption

Based on the worldwide survey and interviews with local stakeholders, this study identified five key areas in the EV industry infrastructure and ecosystem that need special attention and support in order to reduce barriers to the adoption of EVs.

These five areas are:

- a) The Government role in providing EV adoption
- b) The set-up of EV charging infrastructure
- c) Human capital development for EV maintenance and support
- d) The update of type approval regime
- e) The disposal of hazardous materials in EVs, particularly batteries

Chapter 2 Government Role in EV Adoption



2.1 The Role Played by Governments in EV Adoption

This chapter gives an overview of EV adoption in major countries around the world, looking specifically at the roles played by governments in promoting EV adoption in both private and commercial fleets. The study provides comprehensive insight into what other governments have done to support EV adoption, acting as a reference point for the HKSAR Government, allowing it to formulate plans and create measures to promote the adoption of EVs across the board.

2.1.1 The United States

EVs have been promoted to commercial fleets in the US since early 2009. The ultimate goal is to transform the US light-duty ground transportation system from one that is oil-dependent to one powered almost entirely by electricity, enhancing US economic prosperity and safeguarding national security.

The US Department of Energy has initiated a “National Clean Fleets Partnership” programme, in which “Clean Cities” work with large private fleets to cut petroleum use. The initiative provides fleets with resources, expertise and support, allowing them to incorporate alternative fuels and fuel-saving measures – including EVs – into their operations. The programme links municipal governments, private sector operators, utility companies and resource groups in partnerships which promote and share new energy vehicle operation experiences. Earlier this year, a further 13 companies, including Google, Ford and GE

announced their commitment⁵ to the programme and their intention to expand the application, promotion and resources of electric vehicles.

On the infrastructure side, the Department of Energy (DOE) has launched the “Workplace Charging Challenge”, with a goal to achieve a tenfold increase in the number of US employers offering workplace charging stations in the next five years. Even though the programme is a government initiative, it requires the participation of other parties. The DOE is actively calling on American employers to sign the Workplace Charging Challenge Pledge as “Partners” and make a bold commitment to provide PEV charging access to their workforce. The Pledge also

enlists stakeholder organisations as “Ambassadors” who will promote and facilitate workplace charging. The Coca-Cola Company, Facebook and Dell are among 16 companies that joined the Workplace Charging Challenge⁶.



In addition, the government is also providing funding to promote electric vehicle technology and infrastructure support, while at the same time introducing stricter emissions and fuel economy requirements to drive EV adoption in the US.

⁵ Environmental Leader, *Google, Ford, GE Pledge Workplace EV Stations*, 2013, available at <<http://www.environmentalleader.com/2013/02/04/google-ford-ge-pledge-workplace-ev-stations/>>

⁶ Environmental Leader, *Coke, Facebook, 14 Others Pledge Workplace Charging*, 2013, available at <<http://www.environmentalleader.com/2013/03/07/coke-facebook-14-others-pledge-workplace-charging/>>

2.1.2 The United Kingdom



Figure 2-1 Mayor of London announces zero emission taxi

<http://www.thegreencarwebsite.co.uk> [8 Oct 2014]

The UK is aiming to be the world's most EV-friendly country through its direct funding and regulatory policies. In support of this aim, the city of London has proposed that all new taxis will need to be zero-emissions vehicles in order to receive an operating license by 2018, as part of a wider goal to have 100,000 electric vehicles and 25,000 charging points throughout the city.

The city government has three strategies to achieve this goal:

1. **Expand the number of electric vehicles through fleet purchases** – City and central government organisations are the primary target for electrification. Taxis and commercial fleets, such as delivery trucks and vans, are also targets as are public buses where possible.
2. **Build up infrastructure through partnerships** – The government will partner with local boroughs and the private sector to build a charging station every mile. These charging points can be strategically located around off-street car parks, rail station car parks, and at other locations like businesses or shopping destinations.

3. **Provide electric vehicle incentives to promote adoption** – The government will provide incentives including purchase rebates, free parking, and expansion of the congestion charge discount to electric vehicle owners. London's congestion charge is a fee meant to limit vehicle travel in central London's congestion zones. EVs have long enjoyed a 100 percent discount on this fee.

2.1.3 Mainland China

Vehicle electrification is a priority government policy in China, the urgent drivers of this policy being the need to reduce air pollution and achieve energy independency. An existing subsidy programme⁷ for new energy vehicles (NEV) was renewed in September 2013. Through 2015, the central government will focus on promoting the use of NEVs in the three regions anchored by Beijing, Shanghai and Guangzhou. In these regions, the number of NEVs is mandated to reach no fewer than 10,000 by 2015, with all other cities and areas should be having no fewer than 5,000 EVs by the same year.

The central government has also set targets for local authorities to have at least 30 percent of NEVs made by automakers based outside of their jurisdictions, and has directed public agencies to take the lead in using NEVs. At the municipal government level, there are similar guidelines and purchase targets for EVs.

In the recent 2014-2017 “Blue Sky Plan”, Beijing will promote the use of clean energy in public vehicles like buses, taxis and postal trucks. By the end of 2017,

⁷ Bloomberg, *China Renews Electric Vehicle Subsidies Excluding Hybrids*, 2013, available at <http://www.bloomberg.com/news/2013-09-17/china-renews-electric-vehicle-subsidies-without-adding-hybrids.html>

Beijing will have 200,000 vehicles on its roads that are powered by new and clean energy, with about 65 percent of public buses and majority of the city’s taxi fleet using clean energy. The municipal government is also partnering with local and commercial firms to build 10,000 charger stations in support of this plan.

我国出台强力扶持政策 加速新能源汽车健康发展



Figure 2-2 新能源汽车“國六條”政策出爐 加速健康發展
<http://www.evlook.com> [22 July 2014]

Commercial vehicles in public fleets are another important inclusion in the plan. An incentive of RMB 150,000 exists for using EVs to deliver mail, sanitation, garbage, and general goods. The government’s EV support policies have earmarked more key cities for NEV promotion and demonstration trials.

On the vehicle supply side, according to the Ministry of Industry and Information Technology, 628 models were included in the Directory of Recommended Models of Energy-saving. The number of New Energy Vehicles being used for “trial purposes” hit 24,800 in 2012, up 94 percent year on year. Of these, there were 14,700 passenger cars and more than 10,000 commercial vehicles.

In terms of vehicle types, there were 13,300 pure electric vehicles, 10,400 conventional hybrid vehicles, and over 1,000 plug-in hybrid vehicles.

With governments at all levels promoting the use of new energy vehicles, Mainland China is enjoying a rapid growth in electric vehicle usage, especially in the public transportation sector.

2.1.4 Japan

The government of Japan has played a key role in the current success of Hybrid Electric Vehicle (HEV) technology in the marketplace. Beginning in the 1970s, due to energy security issues the Japanese government worked with automakers to create a comprehensive Battery Electric Vehicle (BEV) plan that included R&D technology development, demonstration programmes and market support guides.

The government purposely implemented a purchasing programme, including subsidies (up to 900,000 yen) and the development of niche markets to encourage updates in new technology, but this programme fell short of its original targets. However, the plan established Japan’s leadership in HEV technology around the world, with sales reaching over a million units by 2008.

In fact, Japan offers some of the most robust subsidies in the world, frequently reviewing them to ensure they match current needs. Buyers of new energy vehicles can reap huge benefits, up to a maximum of US \$8,500, based on the price differential between an EV and a comparable Internal Combustion Engine (ICE) vehicle.

The Japanese government acts as a conductor for new infrastructure development. The Industry Ministry (METI) has acted as a development leader

alongside the industry itself, supporting and encouraging new development.

Currently, the government is offering a multi-pronged and holistic approach which is poised to make Japan a leader in electric vehicle proliferation.

2.1.5 Singapore

The government of Singapore encourages the use of public transportation as its top strategy to combat carbon emissions. To promote the use of green vehicles, their National Environment Agency (NEA) introduced a Green Vehicle Rebate (GVR) scheme. In place since 2001, the scheme aims to bring about a change in consumer behaviour to support clean emerging technologies by narrowing the cost differential between a green vehicle and its equivalent conventional model.

To catch up with developments in the industry, the Singaporean government has introduced a new Carbon Emissions-based

Vehicle Scheme (CEVS) to replace the GVR scheme. Under the new scheme, car models with low carbon emissions will enjoy more generous rebates – up to 20,000 Singaporean dollars. The scheme also extends the maximum rebate for pure EVs, as shown in Table 2-1.

The new scheme aggressively targets taxi owners, encouraging them to adopt new EV technology by providing a 50 percent greater rebate than that offered to private EVs. The programme seeks to inspire taxi companies to adopt new electric vehicle technology.

2.2 EV Incentives in Various Economies

Economies around the world have introduced a variety of measures to encourage the adoption of EVs. Table 2-2 provides a list of these various government EV initiatives in 2013:

Table 2-1 Rebate in Carbon Emissions-based Vehicle Scheme introduced by Singaporean Government

CEVS Bandings			
Band	Carbon emissions (CO2 g/km)	REBATE (From 1 Jan 2013)	
		Cars	Taxis
A1	0 to 100	\$20,000	\$30,000
A2	101 to 120	\$15,000	\$22,500
A3	121 to 140	\$10,000	\$15,000
A4	141 to 160	\$5,000	\$7,500

Table 2-2 Government EV initiatives from various economies in 2013

Economy	Government EV incentive and initiatives
Malaysia	Full exemption of import and excise taxes on hybrid and electric cars until 31 December 2013.
Singapore	Under the Carbon Emissions-based Vehicle Scheme, most electric cars qualify for the maximum SG\$20,000 rebate.
UK	The Transport Department announced a subsidy for EV charging infrastructure, paying up to 75 percent of the installation costs, ranging from GBP 1,000 to GBP 10,000.
Japan	Government contributes US\$1.025 billion towards the installation of national electric vehicle charging infrastructure, powered by renewable energy.
Mainland China	Beijing announced EV purchase incentives of RMB 120,000 and an exemption from the need to use the lottery to obtain a new car registration.
France	The government offered drivers a rebate of EUR 7,000 (~US \$9,700) on the purchase of a battery-powered vehicle and EUR 4,000 (~US \$5,555) for a hybrid electric-gasoline model.
Germany	The German automotive industry invested EUR 12 billion (~US \$16.7 billion) in the development of an alternative fuel drive train over the next three to four years.
Italy	Electric vehicles are exempted from the annual ownership tax for five years from the date of first registration. After five years, EVs will receive a 75 percent reduction in the tax rate for comparably-sized petrol vehicles in many regions.
US (Federal Government)	Electric-drive vehicles (EVs and PHEVs) sold after December 31, 2008 receive a \$2,500 to \$7,500 tax credit, depending on the vehicle's battery size (4 kWh to 16 kWh). This is an incentive from the American Recovery and Reinvestment Act of 2009 (the "stimulus bill"), and will apply to at least 200,000 units per vehicle manufacturer before being phased out.
Hong Kong	Full exemption of first registration tax and promotion of charging infrastructure installation. The Government has set up a HK\$300 million Pilot Green Transport Fund to support the testing of green and innovative technologies applicable to the public transport sector and goods vehicles.

2.3 HKPC's Views and Recommendations

2.3.1 Government Plays a Leading Role in EV Adoption

As can be seen from the EV adoption rates in leading economies around the world, governments often play a leading role in coordinating, promoting and encouraging EV adoption. Most governments provide funding support to encourage commercial fleet and private vehicle owners to switch to EVs, while some provide tax incentives. Some countries which prioritise EVs will also develop and initiate special adoption programmes, in particular to assist commercial fleets with EV purchases. For example, in London, while all new taxis will need to be zero emissions by 2018 to receive an operating license; the government provides a number of incentives in return, including purchase rebates, free parking, and a congestion charge discount.

The Hong Kong SAR Government should consider strengthening subsidies and incentive schemes to facilitate a higher EV adoption rate in a more targeted and coordinated manner for private EVs and commercial fleets respectively. A neutral, non-commercial body can be set up to holistically coordinate the promotion and development of Hong Kong's EV industry.

2.3.2 The Importance of a Holistic Plan

With EVs growing more prevalent, it is evident that numerous changes to business models, consumer and user behaviours and many other variables will come about, all of which will be vastly different from the variables involved in the operation of gasoline-powered cars. As is the case with other countries, it will be important to holistically plan and provide support to prepare the ground and make sure Hong Kong is ready for EV adoption. The HKSAR Government may consider initiating

an agency with the sole purpose of strategizing, coordinating and driving the adoption in EVs in the territory.

2.3.3 Recommendation 1

Strengthen and target Government incentives in a holistic and coordinated manner

Governments play an active role in promoting and encouraging EV adoption, as is evident from the experiences in several other countries.

Target commercial fleets for government programmes

– As 90 percent of the roadside air pollution in Hong Kong is generated by commercial fleets, their electrification will be comparatively easy,

since they represent only 20 percent of all Hong Kong vehicles. This study recommends that the HKSAR Government consider setting up more specialised

and targeted programmes such as trial schemes to promote EV adoption in commercial fleets.

Support private EVs with Government EVSE programmes

– The Government should consider strengthening the promotion and augmenting the deployment of EVSE. This can be achieved through incentive programmes, tax concessions and pilot programmes similar to other countries. Hong Kong needs strategic vision regarding EV infrastructure support.

2.3.4 The Role of Government in Private and Commercial EV Adoption

Similar to the case of London, Hong Kong needs to set a goal or a “total picture” for electrification, so that all stakeholders can participate and share the burden.

Two broad areas for private and commercial fleet EV adoption can be studied when considering strengthening government support and incentives.

(a) Infrastructure support for private EVs

While the number of privately-owned EVs is steadily rising, the promotion of private EVs is mostly – and rightfully – performed by car vendors in a similar manner to gasoline powered car promotion. As in other countries, the government can provide support and facilitate the setup of EV-related infrastructure and charging points for private EVs. While high-speed chargers have the advantage of being able to charge EVs in under 30 minutes, they are expensive to set up. As such, an optimal proper mix of EV chargers should include both medium- and high-speed chargers, while slower chargers will be slowly phased out.

(b) Incentives and special programmes for commercial fleets

Vehicle pollution is a significant factor in any populated city. In Hong Kong, emissions from diesel-powered commercial vehicles including trucks, buses and public light buses produce large amounts of airborne particles and nitrogen oxide, which are harmful to human health. In

crowded urban environments with busy roads, trapped pollutants at street level can increase the ambient temperature and have significant health implications. Similar to London and Beijing, the Government should initially consider targeting commercial fleets for EV expansion.

Commercial fleets such as franchised buses are suitable targets for electric vehicle or hybrid electric vehicle adoption schemes. Replacing diesel-powered vehicles will appreciably reduce airborne particles and nitrogen oxides at street level. Locally, there are only three bus company operators, meaning it will be relatively easy to manage EV adoption using a phase-in plan when renewing contracts.

The HKSAR Government should consider setting up more special targeted programmes such as trial schemes to promote of EV adoption amongst commercial fleets.

Similarly, taxis, public minibuses and other types of commercial fleets can also develop phase-in plans to guide fleet replacement, allowing any new replacement to be electric vehicles.

EVs are a new class of vehicles, for which many new technologies are being developed. Commercial fleets may also be encouraged to adopt new technology such as battery swapping, wireless charging and super capacitors. These technologies could also be trialled with Government support when they become mature enough for public trials.

(c) Feasibility of battery swapping technology and infrastructure

Many in the industry are keen to use battery-swapping technology for EVs in commercial fleets, as it will save time in charging their fleet EVs.

Battery packs equipped with GPS, RFID and other communications devices will also help companies keep track of the movement of a battery across its entire lifespan, from manufacture to disposal. This will allow both authorities and manufacturers to track how a battery is disposed of at the end of its service life. In addition, GPS and other communications

devices will give operators vital analytic information on movement, allowing them to determine the best place to set up battery swapping facilities. A public trial with franchised buses should be strongly considered, as battery swapping facilities can be set up at bus terminals and depots, alleviating key space issues.

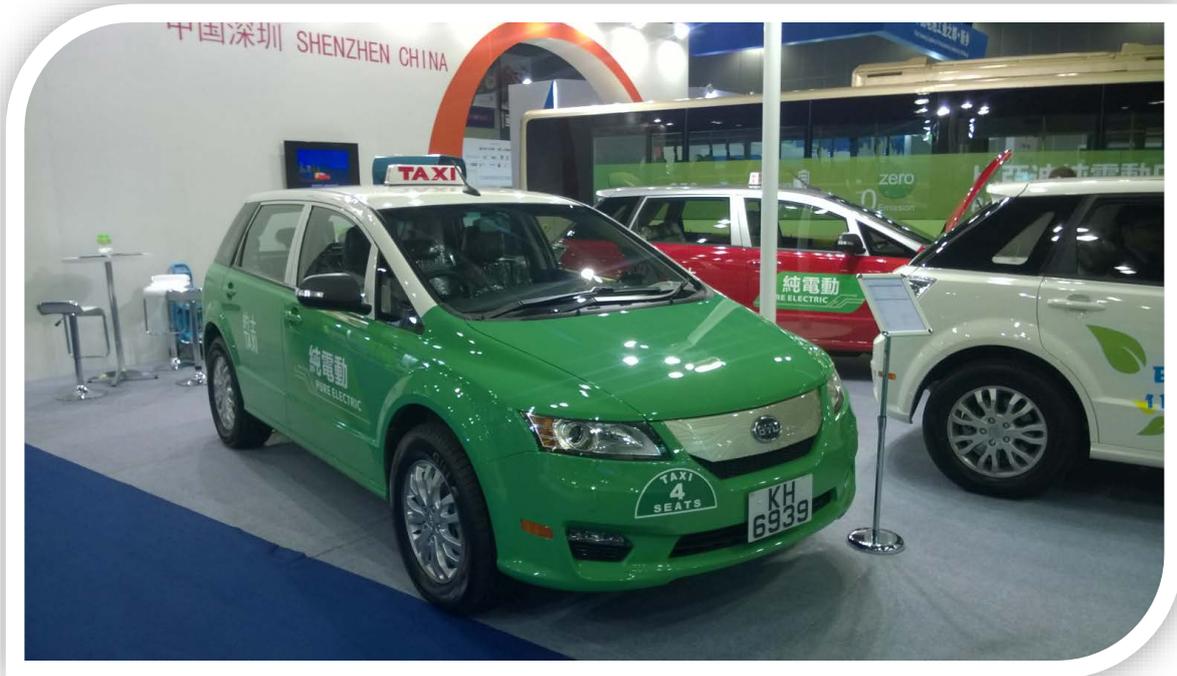
Table 2-3⁸ below illustrates important statistics for different commercial vehicle types in Hong Kong. The five franchised bus companies and green Public Light Buses carry a daily total of 3.42 million passengers, mostly in urban areas along close to 1,000 fixed routes. Any reduction in air pollution would be highly significant to these millions of passengers and the people living along these routes.

Table 2-3 Statistics for different commercial vehicle types in Hong Kong

Vehicle Class	No. of Routes	No. of Licensed Vehicles	Passenger Per Day
Kowloon Motor Bus	372	3,867	2.59M
New World First Bus	91	721	0.5M
Citybus	110	957	0.16M
Long Win Bus	19	172	0.1M
New Lantau Bus	22	108	0.07M
Public Light Bus (green)	350	3,110	1.5M
Public Light Bus (red)	No fixed routes	1,236	0.35M
Taxis		18,071	1 M
Non-Franchised Buses		6,873	Data not available
Heavy Goods Vehicles		4,851	
Light Goods Vehicles		75,190	
Petroleum Private Cars		478,193	
Petroleum Motorcycles		42,096	

⁸ Transport Department, *Registration and Licensing of Vehicles by Class of Vehicles*, 2013, available at <http://www.td.gov.hk/filemanager/en/content_281/table41a.pdf>

Chapter 3 Local Industry Views on EV Adoption



3.1 EVs – A Solution to Air Pollution

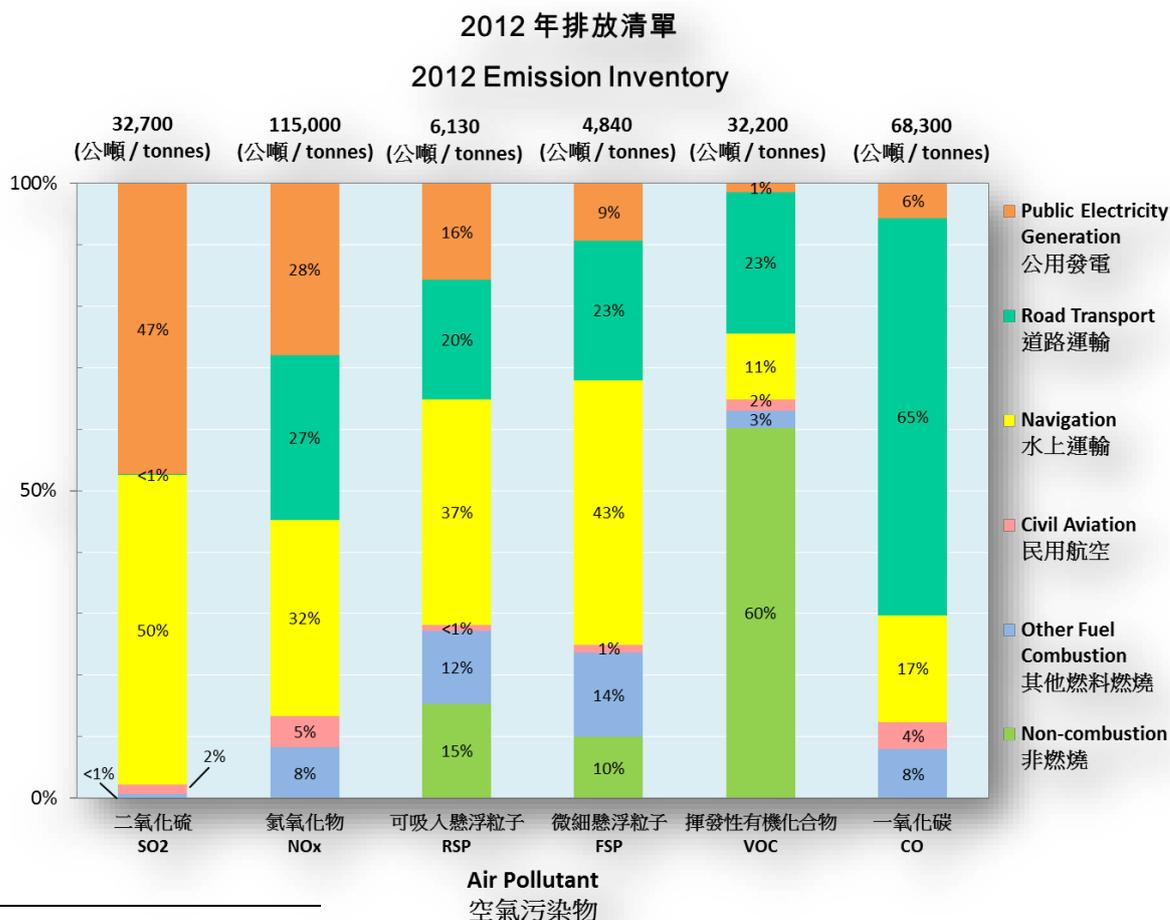
Electric vehicles can be a viable road transport alternative. With zero pollutant emissions, they are an ideal solution to air pollution from road transport – a major contributor to pollution emissions.

The diagram below shows the emission inventory⁹ for 2012, listing various emission source categories including public electricity generation, road transport, navigation, civil aviation, other fuel combustion sources and non-combustion sources.

For a number of years, the Governments of the Hong Kong SAR and Guangdong Province have been close collaborating partners, working to improve the air quality in Hong Kong and the Pearl River

Delta (PRD) region. According to a new set of emission reduction targets valid up to 2020 endorsed at a meeting of the Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection held in November 2012, Hong Kong will implement the following key measures to achieve emissions targets set for 2015 and 2020:

1. Tightening vehicle emission standards;
2. Phasing out highly-polluting diesel commercial vehicles;
3. Retrofitting Euro II and Euro III franchised buses with selective catalytic reduction devices;
4. Strengthening the inspection and maintenance of petrol and liquefied



⁹ Environmental Protection Department, *Hong Kong Air Pollutant Emission Inventory, 2014*, available at <http://www.epd.gov.hk/epd/english/environmentinhk/air/data/emission_inve.html>

petroleum gas vehicles;

5. Requiring ocean-going vessels to switch to low-sulphur fuel while at berth;
6. Tightening the cap on the sulphur content of locally-supplied marine diesel;
7. Controlling emissions from off-road mobile machinery;
8. Further tightening the emission caps on power plants;
9. Controlling the VOC content of solvents used in the printing and construction industries.

The top four measures are directly related to the transportation sector and vehicle technology and in this regard, the HKSAR Government has been active in setting up incentive programmes to promote electric vehicles for road transportation.

3.2 Obstacles to EV Adoption in Hong Kong

Many countries face obstacles to EV adoption and Hong Kong is no exception. Although government incentives for EV adoption do exist, such as the Pilot Green Transport Fund, EV adoption in Hong Kong is still in an initial stage in both the private car and commercial vehicle markets.

A dissertation entitled “Who killed the electric car in Hong Kong?”⁹ contains a detailed discussion on the obstacles to EV promotion and uptake in Hong Kong. One key obstacle is the lack of easily-accessible charging infrastructure in residential buildings and around the city.

As of June 2013, the Transport Department reported ¹⁰ an approximate total of 708,000 parking spaces in the city. However, there are only about 1,100 available charging points with significantly less than one percent of residential buildings having electric car chargers. Many property management companies and owner committees¹¹ are not keen to install EV chargers in their properties because of concerns about high installation costs, safety considerations and revenue generation concerns regarding charging. Indeed, a quick-charging station above 100A can cost close to one million dollars to install, making quick chargers even less popular with property owners.

3.3 Government Incentives to Promote EV Adoption in Hong Kong

In 2009, the Hong Kong SAR Government established a steering committee on EV application in Hong Kong. At the same time, the government has become quite active in promoting the use of EVs. According to the Environmental Protection Department, the following measures have been enacted¹²:

1. The first Registration Tax for EVs is waived till end of March 2017. Enterprises which procure EVs are allowed a 100 percent profits tax deduction for capital expenditure on EVs in the first year of procurement.
2. A HK\$ 300 million Pilot Green Transport Fund was put in place in March 2011. The fund allows applications from

¹⁰ Tsang, Chun-kit, Who killed the electric car in Hong Kong? 2012, available at <http://hub.hku.hk/handle/10722/174585>

¹¹ 香港文匯報, 裝電動車充電設施 邱騰華籲法團配合, 2011, available at <http://paper.wenweipo.com/2011/11/24/HK1111240026.htm>

¹² http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/promotion_ev.html

transport operators, non-profit-making organisations providing services to their clients and goods vehicle owners, encouraging them to try out innovative green and low-carbon transport technologies, including EVs.

3. The ultimate policy objective of the Government is to have zero-emission buses running across the territory. To this end, the Government has allocated HK\$180 million to allow franchised bus companies to purchase 36 electric buses. These will be used in trial runs to assess their operational efficiency and performance under local conditions. The trial is expected to commence progressively beginning in the first quarter of 2015.
4. On the infrastructure side, the Government has set up charging points and 100 medium-speed charger stations in public parking facilities across the territory. They are actively encouraging utility and other companies to set up 10 quick charging stations across Hong Kong.

3.4 Private Cars

Transport Department statistics state that there are 525,753 and 3,067 registered private cars powered by petrol and diesel engines respectively. These cars make up 70 percent of the total registered vehicles in Hong Kong. As the lifecycles of private cars are much shorter than those of commercial vehicles, the emissions produced by new private cars powered by newer, more efficient engines are normally much lower than commercial vehicles. The two major considerations for private car owners when selecting between EVs and traditional vehicles are the “operational

costs” and “availability of charging infrastructure”.

The operating cost ratio between a petrol-powered private car and battery-powered one is about 10:1. This makes using an EV attractive from a cost point of view, even when taking maintenance costs into consideration. Given this factor, the availability of charging infrastructure becomes the critical factor influencing a buyer’s decision to switch to an EV in the private car market.

Most private car owners only drive their car between their place of work and their home. As such, the availability of charging points near their offices and homes will be crucially important when making their decision on whether to change to an EV. Good infrastructure with a balanced combination of quick chargers and semi-fast chargers at numerous locations around the city should increase the confidence level of private car owners, allowing them to select an EV as their family car. Additionally, locating EV charging points in their residential car parks will remove a major obstacle to EV adoption amongst private car owners.

To ensure that these obstacles are removed, the Government, both power companies, property developers, property management companies, EV charging facility providers and EV service providers need to work together. These groups must resolve the current EV charging point set up issues in terms of business and electricity fee charging models, the cost of setting up equipment and power supply infrastructure set up.

3.5 Commercial Fleets

A commercial fleet is a group of commercial vehicles (usually configured similarly) which provide services or delivers goods to customers. This study focused on soliciting views on EV adoption from five typical categories of commercial fleets in the following businesses:

- Logistics (light duty)
- Logistics (heavy duty)
- Retail industry
- Public transportation (taxi and light bus)
- Public transportation (non-franchised bus)

The nature of the business of a commercial fleet holder plays an important role in determining the operation mode of that fleet. In this study, the operation modes of the above five commercial fleet categories were analysed in terms of their feasibility for EV adoption. The study found that there are three common characteristics among the commercial fleets which favour the wider adoption of EVs:

Centralised gathering points make EVSE installation easier

First, all five categories of commercial fleet have mostly centralised gathering points. This can facilitate EV adoption, as Electric Vehicle Supply Equipment (EVSE) can be built at these points to ensure efficient EV charging.

Single decision-maker for most commercial fleets

Second, commercial fleets are usually owned by a single owner. In other words, only one major company holds the decision-making authority regarding EV

adoption. This makes it more effective and efficient to persuade commercial fleets to switch to EVs.

Suitable EVs already available

Third, there are readily-available EV models already on the market which can fulfil the operational and business needs of these five commercial fleet categories. If these fleets were to adopt EVs, this would make a significant impact in terms of emissions reduction. According to statistics from the Environment Bureau¹³, in 2011, these five commercial fleet categories accounted for 47 percent of nitrogen oxides emissions and 37 percent of PM10 emissions.

Since the number of vehicles in these types of commercial fleets equates to only 22 percent of the total number of licensed vehicles in Hong Kong, switching these fleets to EVs is undoubtedly a cost-effective means of reducing air pollution. It is also reasonable to assume that commercial fleets will adopt similar vehicle models for their fleets. Therefore, a single type of EVSE can serve a whole commercial fleet, further reducing the set up cost of charging points.

¹³Environment Bureau, in collaboration with the Transport & Housing Bureau, Food & Health Bureau and Development Bureau, HKSAR, "A Clean Air Plan for Hong Kong", March 2013, available at <http://www.enb.gov.hk/en/files/New_Air_Plan_en.pdf>

Table 3-1: Comparison of five commercial fleet categories

	Logistics (light duty)	Logistics (heavy duty)	Retail Industry	Public Transportation (Taxi and Light Bus)	Public Transportation (Non-franchised Bus)
Business Nature	Provision of local express delivery and logistics services, e.g. collection and delivery of parcels and mail.	Provision of international delivery and cargo shipping services.	Distribution of goods to retail stores.	Provision of daily transportation services for the general public. Examples include taxis and light buses.	Provision of tailor-made bus services to specific groups of passengers, e.g. tours, hotels, students, employees, international passengers, building residents and contract hire services.
Organisational Examples	i) DHL ii) FedEx	i) DHL ii) FedEx	i) Wellcome, ii) PARKnSHOP	i) Urban Taxis ii) RMB	i) Kwoon Chung Bus Company
Types of Vehicles	i) Light goods vehicles	i) Light and medium goods vehicles	i) Light and medium goods vehicles	i) Taxis ii) Light buses	i) Non-franchised buses
Vehicle Operation Modes	i) Frequent travel ii) Long distances iii) Flexible routes	i) Frequent travel ii) Long distances iii) Flexible routes	i) Do not travel frequently ii) Long distances iii) Fixed routes	i) Frequent travel ii) Long distances iii) <u>Taxis</u> - Random routes; <u>Light Buses</u> - Regular travel times and fixed routes	i) Regular travel times ii) Fixed routes
Gathering Points	i) Car parks ii) Warehouses	i) Car parks ii) Warehouses	i) Car parks ii) Warehouses iii) Distribution centres	i) <u>Taxi</u> - Taxi stands ii) <u>Light bus</u> - Minibus bus terminuses	i) Car parks

3.6 Experiences and Views from Major Commercial Fleet Stakeholders

The project team identified three major commercial fleet stakeholders from which the project team collects information and views. These stakeholder groups were:

- (a) Fleet operators
- (b) Landlords
- (c) Property developers

3.6.1 Methodology of Collecting Stakeholder Views

Views were collected at the HKPC Industry Network Cluster (INC) consultation in June 2013, and via phone interviews and email surveys. Three separate sets of questionnaires were tailored to the three stakeholder groups, gathering the following information:

- (a) Operation information
- (b) Concerns about EV adoption
- (c) Expectations on the use of EVs
- (d) Expectations on Government support

3.6.2 Views Collected

The collected views were consolidated with the stakeholders' major concerns listed as follows:

Stakeholders' Concerns about EV Adoption

The interview results revealed that the three stakeholder groups have common concerns on EV adoption, which are divided into six major types:

- (a) Cost considerations;
- (b) Concerns about EV charging and range;
- (c) Concerns about EVSE cost, safety and standards;

- (d) Reliability of EVs and availability of repair personnel;
- (e) Concerns about EV batteries;
- (f) Other concerns.

A. Cost considerations

The greatest common stakeholder concerns were the price disparity between EVs and conventional internal combustion engine vehicles. The initial investment involved in purchasing an EV is large due to the high cost of the battery. In terms of operation costs, the price of electricity is low compared to the price of diesel or gasoline; however the large initial capital outlay on the purchase of an EV lengthens the break-even time. Some fleet operators claimed that the required break-even time for the extra EV capital investment was 15 years, thus hindering their desire to adopt an EV.

B. Concerns on EV Charging and Range

Charging is an essential and recurrent process for EVs. Concerns about long charging times and the comparatively short range of EVs have been raised by many fleet operators. They thought that the long EV charging time would not only increase the "time cost" of operating an EV fleet, but that it would also disrupt the normal operation of their commercial fleet. Typically, an electric bus takes three to four hours to charge. However, most interviewees benchmarked the charging time against the time required for refilling a petrol tank. As such, they thought that charging their EV fleets during a shift was unfeasible. The limited locations and limited availability of EVSE further exacerbated this problem.

C. Concerns about EVSE cost, safety and standards

Interviewees from both the landlord and property developer groups expressed concerns about the cost of installing and providing EVSE, as well as the financial return. When preparing to install EVSE, it is necessary to run power supply cables with extra power capacity from a transformer station to the installation site. The stakeholders saw this as an expensive step, as the set up of high-current power lines to certain premises, particularly at remote locations, could run to a million dollars or more. Meanwhile, the installation of extra power cables might also cause hidden safety problems like overloading a building's transformer room.

Landlords and property developers also expressed the view that it was difficult to choose a suitable standard. There are currently four major EV charging standards – US, Europe, Japan and China. The interviewees were not aware of this fact and were unsure about what the prevailing standard in Hong Kong was or would be.

Some landlords also raised the point that the installation of EVSE would occupy several parking spaces, which in turn would lower their revenue from parking space leasing. In short, considering the high installation costs, safety issues and the lower returns on parking spaces, the landlords and property developers had several reservations about setting up EVSE and higher EV adoption.

D. Reliability of EVs and availability of repair personnel

Some fleet operators expressed their uncertainty about the performance of EVs, such as the length and frequency of downtime. The reliability of EVs directly affects the operation of commercial fleets

and a firm's outlay on maintenance and repair costs.

Many interviewees raised reservations about the reliability and service life of EVs. They had concerns about maintenance and repair costs for EVs which are still relatively new-to-market and have no "street mechanic" support. In addition, the high cost of EV batteries increases the operation costs of EVs, when the cost of battery replacement is considered. The potential costs of frequent maintenance and repair works were a deterrent to adopting EVs for the interviewees.

They also expressed views that there is currently insufficient information available on the reliability and performance of various EVs.

E. Concerns about EV batteries

Some interviewees expressed concerns about the environmental impact of EV battery disposal and safety issues regarding the use of EV batteries. They also pointed out that not enough information is available on the safe disposal of EV batteries.

F. Other Concerns

Other concerns included the fact that some fleet operators found it difficult to find suitable EV models in the market. Some also expressed concerns about driver acceptance of EVs. Fleet operators agreed that more information about EVs is needed before they would consider switching.

Landlords and property developers expressed their concerns about the utilisation of EVs and EVSE, admitting that the current low utilisation rate of EVs reduced their willingness to install EVSE.

Stakeholders' Expectations Regarding EVs

The study found that the stakeholders had the following expectations on the use of EVs in their own operations:

A. Building CSR image

The interviewees generally believed that EV adoption would contribute to environmental protection. They were keen to leverage the use of environmentally-friendly EVs to boost their corporate social responsibility (CSR) image.

B. Fuel consumption cost reduction

The fuel cost of EVs is much lower than diesel or gasoline powered vehicles. This is a key motivation for companies considering adopting EVs. The interviewees expected the cost of vehicle operation would be lowered with the fuel cost reduction.

C. Comparable performance of EVs with conventional internal combustion engine vehicles

From a fleet operator's point of view, the adoption of EVs should not affect the normal operation of the commercial fleet. Thus, these stakeholders deemed it necessary for the performance of EVs to be comparable to the performance of conventional vehicles in terms of reliability, range and safety.

Stakeholders' Expectations regarding Government Support

The study found that stakeholders had various expectations about the level and manner of support from the Government.

A. Implement a "user-pay principle"

Interviewees thought that a "user-pay principle" was acceptable to EV users; meaning that the cost involved in charging an EV would be borne by users or fleet operators. Despite this prevailing view, they were also of the fact that a financial incentive from the Government would increase their interest in early EV adoption.

B. Provide funding support or incentive schemes

The interviewees were generally of the view that financial incentives from the Government were necessary at this early stage, as they were uncertain about EV performance and cost effectiveness. They made the following suggestions on various types of incentive schemes:

- i) Funding support for EVSE installation costs;
- ii) Funding support for EV repair and maintenance costs;
- iii) Tax reduction on the purchase of EVs when replacing existing conventional internal combustion engine vehicles;
- iv) Special parking and tunnel toll allowances for EVs;
- v) Provision of rent-free spaces for the set up of EV parking and charging stations.

C. Lift restrictions on electricity charging for EVSE

As Hong Kong does not have a franchise arrangement on the supply of electricity, landlords or owners of EVSE installations are not allowed to charge EV owners for the use of electricity, since this is viewed as "re-selling" electricity, which violates the supply agreement with the power companies. Only power companies are allowed to directly charge for the use of electricity. Some interviewees were of the view that this restriction by the power

companies needed be liberalised or lifted in order to encourage more landlords or operators to install EVSE.

D. Encourage industry partnerships on EVSE installation

Partnerships between industry stakeholders regarding EVSE installation can create a win-win situation for power companies, property developers and other industry stakeholders. When power companies partner with property developers, the provision of EVSE installation services will help property developers save on installation costs, while helping power companies increase their revenue through the increased use of electricity at EVSE points. At the same time, Industry stakeholders will also benefit from the increased number of EVSE points, making the charging of EVs more convenient.

E. Provide guidelines on the proper disposal of EV batteries

Improper disposal of EV batteries can cause adverse environmental impacts. Some interviewees suggested that the Government should set up clear guidelines on the safe disposal of EV batteries.

F. Carry out independent tests on EVs and EV batteries

To many interviewees, EVs were a new and unfamiliar product, with some noting the lack of availability of information on EVs and EV batteries. While many carmakers make claims on the range, charging time and battery life of their EVs, there are currently no independent parties in Hong Kong to test and verify these claims. The stakeholders suggested that the Government should provide more information to the public about EV and EV batteries. The Government or an

independent party can then carry out tests on key specifications of popular EVs in Hong Kong. The results of these tests could then be published, providing vital information to potential EV adopters.

Some suggested test topics included:

i) The price and specifications of EVs and EV batteries

Information on specifications and pricing for all EVs on the market would enable potential EV users and fleet operators to choose the appropriate EV models and EV batteries.

ii) Health and safety assessments on the use of EVs and EV batteries

By knowing more about the health and safety implications of using EVs and EV batteries, fleet operators would gain clarity on the relevant issues and thus peace of mind when making EV adoption decisions.

iii) Environmental friendliness of EVs

The interviewees wanted a detailed comparison of air pollutant emissions between EVs (including hybrid EVs) and conventional internal combustion engine vehicles. This information would be of use to environmentally-motivated fleet operators or those interested in building their CSR image.

3.7 Key Findings and HKPC's Views About Local EV Adoption

Many interviewees had considered replacing their existing conventional vehicles with EVs in order to save fuel costs and contribute to improving the environment. However, their markets are very competitive and they have many concerns, summarised in section 3.6.2.

To address these concerns, industry practitioners have the following suggestions for the Government to increase the level of EV adoption in Hong Kong:

1. Provide more funding support and incentive schemes to motivate industry practitioners to adopt EVs;
2. Lift restrictions on EVSE electricity charging;
3. Encourage industry partnerships regarding EVSE installation;
4. Provide guidelines on the proper disposal of EV batteries; and
5. Provide independent test reports regarding EVs and EV batteries.

As mentioned in earlier chapters, 90 percent of Hong Kong's roadside air pollution is generated by commercial fleets. These are "low-hanging fruit" which can maximise the effectiveness of Government support. Targeting commercial fleets with government incentives and support regarding EV adoption is relatively straightforward, as commercial fleets are generally owned by single decision-makers, and have mostly similar vehicle types. On the whole, providing incentives and education, as well as appropriate government regulatory changes will help address the concerns of fleet operators, landlords and property developers in terms of EV adoption.

3.8 Key Areas to be Studied in the Promotion of EV Adoption

After conducting international desktop research and the local interviews, the study identified four key areas for further in-depth study and analysis which may promote greater EV adoption in commercial fleets and private cars alike.

Detailed studies in these areas will allow Government initiatives, support and incentives to be better targeted and more effective.

These four key areas will be covered in the next four chapters of this study, namely:

- EVSE and infrastructure
- Human capital development
- Type approval regime
- Safe disposal of battery and parts

Chapter 4 EVSE and EV Infrastructure in Hong Kong



The provision of Electric Vehicle Supply Equipment (EVSE) – commonly located at EV charging points within EV charging stations – is critical to the successful adoption of EVs. This equipment is responsible for safely delivering electricity to EVs. This chapter reviews the deployment of EVSE in foreign countries and the current deployment status in Hong Kong, concluding with HKPC’s analysis and recommendations for the expansion of the EVSE network in Hong Kong.

4.1 Review of Available EVSE Technology and Standards

A charging point provides charging facilities for EVs, and is usually located in a car park. A charging station may have a number of charging points, each of which contains a set of charging equipment – the EVSE – used for charging an EV.



(a)



(b)



(c)

Figure 4-1 EV Charging Infrastructure (a) Charging Station (b) Charging point (c) EVSE



(a)



(b)



(c)

Figure 4-2 (a) Standard Charging EVSE with 13A socket outlet (b) Charging cable assembly
(c) BS1363 standard plug

The EVSE or “charger” will conform to one or more of the International Standards for Charging Equipment (e.g. IEC 61851 or UL2594). Apart from charging an EV, EVSE contains protection devices and controllers to communicate with EVs to ensure a safe charging process, given the

high electric current necessary to charge an EV.

Broadly, EVSE can be classified into three categories based on the time required for charging and the type of electricity used: “Standard Charging”, “Semi-Quick charging” and “DC Quick charging”.

4.1.1 Standard Charging EVSE

Standard charging EVSE, also known as Level 1 EVSE, provides alternating current (AC) power to charge an EV through a standard household-type socket. This is accomplished via a charging cable assembled with an “In-cable Control box” which performs control and safety functions. The standard BS1363 13A socket and plug (i.e. 3-rectangular-pin, 220V AC single-phase) are used in standard charging EVSE in Hong Kong. Standard EVSE typically provides 2.2kW charging power, with a sedan typically requiring 10 hours to be fully charged.

4.1.2 Semi-quick Charging EVSE

Semi-quick charging EVSE, also known as Level 2 EVSE, provides alternating current (AC) to charge an EV via a dedicated charging cable assembly and connector. This equipment is used not only for power transmission but also for signal communication to ensure that the EV is charged under safe and secure conditions.

Two types of standard connectors are commonly used in semi-quick charging EVSE; these are IEC type 1 (also known as SAE J1772) and IEC type 2. The former is a 5-pin connector suitable for single phase power transmission and is usually used in the US and Japan; while the latter is a 7-pin connector suitable for both single-phase and three-phase power transmission which is usually used in Europe.



Figure 4-3 Semi-Quick charging EVSE



Figure 4-4 DC Quick charging EVSE



Figure 4-5 IEC Type 1 EVSE connector (a) EVSE socket outlet (b) Plug



Figure 4-6 IEC Type 2 EVSE connector (a) EVSE socket outlet (b) Plug

On the surface, these two standards appear to be incompatible, however EVs of one type can still be charged by the EVSE of another type, as firstly, a conversion cable assembly exists and secondly, both types use the same communication protocol. A semi-quick charging EVSE has a higher charging power, generally ranging from 7kW to 43.5kW. This equipment allows for faster charging and can shorten EV charging time to between one and six

hours. Depending on the power ratings of the EV and EVSE, Level 2 charging can reduce charging time by 40 to 90 percent when compared to level 1 charging.



Figure 4-7 Conversion cable assembly type 1 (EV) – type 2 (EVSE)

4.1.3 DC Quick Charging EVSE

DC quick charging EVSE, also known as Level 3 DC quick charging EVSE, is more sophisticated and much larger in size than standard and semi-quick EVSE. This equipment is equipped with an off-board charger that transforms AC power to Direct Current (DC) power to charge the EV battery directly with a much higher current than Level 1 and 2 chargers.

There are a number of standards for DC quick charging EVSE, which have different communication protocols. This results in an interoperability problem that cannot be solved simply by connecting a conversion cable assembly or an adaptor, as in the case of Level 2 chargers. Generally, DC quick charging EVSE can provide charging power of 50kW, which can charge an EV to 80 percent of its battery capacity within 20 to 30 minutes. However, this faster charging brings with it higher hardware

and installation costs, as listed in Table 4-1.

4.1.4 Proprietary Charging and Wireless Charging EVSE

Apart from the three charging methods mentioned above, there are other types of EVSE: wireless and proprietary charging EVSE. These are not discussed in this chapter as they are less common in Hong Kong.

Table 4-1 Comparison of standard, semi-quick and DC quick charging EVSE

Charging Method	Power Supply	Charging Time	EVSE Cost (excludes installation cost)
Standard (Level 1 AC)	AC220V, 10A (limited by EV) 2.2kW	10 – 11h (0 to 100%)	HKD 2,300 – 3,900 (US \$300 – 500)
Semi-Quick (Level 2 AC)	220V 16A – 64A 7 – 43.5kW	1 – 6h (0 to 100%)	HKD 7,800 – 55,000 (US \$1,000 – \$7,000)
DC Quick Charger (Level 3 DC)	DC 480V – 600V 100A 50kW	20 – 30 min (0 to 80%)	HKD 156,000 – 390,000 (US \$20,000 – \$50,000)

4.1.5 Deployment of EVSE in Japan, Singapore, UK and US

According to the report *Pathways to High Penetration of Electric Vehicles*¹⁴, the US and Japan are the two countries with the largest markets for EV sales. EVSE deployment is a key factor to EV sales success. On the EVSE side, the publication *Global EV Outlook*¹⁵ published by the International Energy Agency, lists the UK as being one of the top five European markets for EV supply equipment. Singapore, on the other hand, has a similar economy and demographics to Hong Kong. EVSE deployment in these four countries is reviewed in this report.

The proportions of the three EVSE types –

for public-access EVSE only – in Japan¹⁶, Singapore¹⁷, the UK¹⁸, US¹⁹, and Hong Kong²⁰ are compared below.

The proportion of public semi-quick EVSE is much higher in the US, Japan and the UK. In the former two countries, one major concern is the lower supply voltage. The supply voltage of an EVSE is the same as the main power voltage, which is 120V in the US and 100V in Japan. With such a low supply voltage, the charging time for an EV like the Nissan Leaf can take as long as 20 hours – this is not a practical solution, particularly when a car park has only a few EV parking spaces. As a result, these two countries focused on promoting the availability of semi-quick EVSE on a much larger scale at the initial stages of EVSE

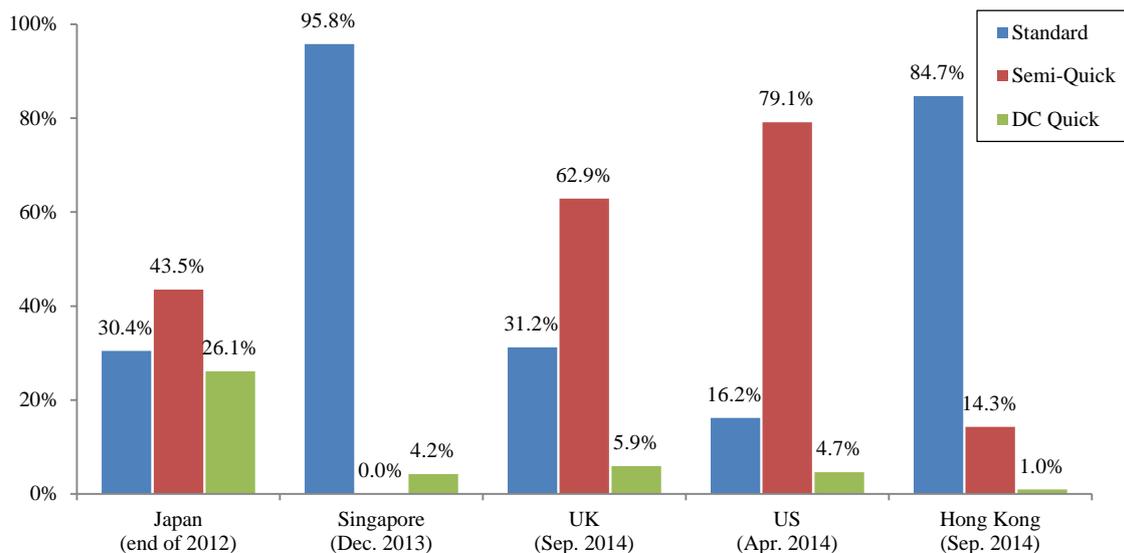


Figure 4-8 Proportions of publicly-available EVSE in Japan, Singapore, the UK, US and Hong Kong

¹⁴ Element Energy Limited, Pathways to high penetration of electric vehicles, 2013
http://www.theccc.org.uk/wp-content/uploads/2013/12/CCC-EV-pathways_FINAL-REPORT_17-12-13-Final.pdf
¹⁵ International Energy Agency, Global EV Outlook, 2013
<http://www.abb-conversations.com/2014/03/electric-vehicle-market-share-in-19-countries/>

¹⁶ Next Generation Vehicle Promotion Center, 平成 24 年度電気自動車・充電インフラ等の普及に関する調査, 2013 (2012 data are used for Japan due to lack of proportion data in recent years)
<http://www.cev-pc.or.jp/chosa/download.html>
¹⁷ Energy Market Authority, *Electric Vehicles Test-Bed*, 2013
<http://www.ema.gov.sg/page/123/id:81/>
¹⁸ Energy Efficiency & Renewable Energy, Department of Energy, *Electric Vehicle Charging Station Locations*, 2014
http://www.afdc.energy.gov/fuels/electricity_locations.html
¹⁹ Next Green Car, *Zip-Map*, 2014
<https://www.zip-map.com/statistics/>
²⁰ Environment Bureau, *Locations of Charging Stations for Public Access*, 2013
http://www.enb.gov.hk/en/resources_publications/guidelines/

deployment.

The UK also has a high proportion of publicly-available semi-quick EVSE. The document *Making the Connection: The Plug-In Vehicle Infrastructure Strategy* published by the UK Department for Transport states that the industry – represented by the Society of Motor Manufacturers and Traders’ Electric Vehicle Group, the “Plugged-In Places” fund, and the Institution of Engineering and Technology’s Electric Vehicle Group – expressed a pressing need to move to a dedicated plug-in vehicle recharging connector (the IEC62196-2 Type 2) to allow faster recharging rates (up to 32A). Since then, the government has taken account of this clear direction and has begun implementing semi-quick EVSE.

Japan is the most successful country in terms of deploying DC quick charging EVSE, due to the high level of government subsidies. DC quick charging EVSE now accounts for 26 percent of the total amount of EVSE. Thanks to its charging speed, DC quick charging EVSE is playing a crucial role in promoting the wider adoption of EVs. The Government of Japan provided subsidies for the installation of charging facilities totalling 100.5 billion yen (HKD 7.6 billion) as part of its fiscal year 2013 economic policy, aiming to increase the number of semi-quick EVSE by 8,000 and DC quick charging EVSE by 4,000.

In comparison, Singapore has very high proportion of standard EVSE. This equipment was installed during the government’s first phase trial, where only 68 standard and three DC quick charging EVSE were deployed. The two-and-a-half year trial period for this “EV Test-Bed” programme has now expired, and a review of collated data is currently underway. Greenlots, a global provider of electric vehicle networks, has partnered with BMW

Group Asia to roll out up to 30 semi-quick EVSE across 20 strategic public locations in Singapore in 2014.

4.1.6 Incentive Schemes

The governments of the US, the UK and Japan all encourage the installation of EVSE through incentive schemes.

In 2010, the £30 million “Plugged-in Places” fund programme was initiated by the UK government, encouraging businesses and public sector partners to install charging points. Features of the fund include:

- up to £13.5 million for a 75 percent grant (capped at £900 or HKD 11,400) for homeowners to install a domestic charge point;
- up to £11 million for local authorities in England to cover 75 percent of the cost of installing on-street charging and rapid charging points;
- up to £9 million available to fund the installation of charging points at railway stations;
- up to £3 million to support the installation of charging points on government land and wider public estates by April 2015.

Over 5,500 charge points have now been deployed through the project. In 2013, the UK government announced another £37 million of funding for infrastructure investment up to 2015.

Between 2009 and 2013, the US government invested US\$230 million in the “EV Project” programme to (i) collect and analyse data to characterise vehicle use in diverse topographic and climatic conditions; (ii) evaluate the effectiveness of existing charging infrastructure; and (iii) conduct trials of various revenue systems for

commercial and public charging infrastructures. During the course of this project, 11,846 semi-quick EVSE and 87 DC quick charging EVSE were deployed. Currently, the Federal government offers a tax credit equal to 30 percent of the installation price with a maximum credit of up to US \$1,000 (HKD 7,800) for each station for individuals and up to US \$30,000 (HKD 234,000) for commercial buyers.

Various scales of incentives are also provided by State governments across the US. In California for example, the Los Angeles Department of Water and Power (LADWP) provides US \$750, \$1,000, or \$15,000 (HKD 5,800, 7,800, or 116,000) rebates to commercial customers to be used towards the purchase and installation of semi-quick or DC quick chargers. In addition, the Bay Area Air Quality Management District (BAAQMD) awards up to US \$20,000 (HKD 155,000) grants for each DC quick charging EVSE installed which meets programme requirements.

The Japanese government provides subsidies for both private and public EVSE installation. For public applications, such as shopping malls, gas stations and public car parks, a basic 50 percent of the purchase and installation costs can be subsidised. The incentive can be increased to 67 percent if the EVSE installation follows the plan of the local government or highway agency.

In July 2013, four automakers – Toyota, Nissan, Honda and Mitsubishi – announced an agreement with the Japanese government to support the goal of installing 4,000 DC quick EVSE and 8,000 semi-quick EVSE, collaborating to build a convenient and accessible charging network. The automakers pledged to bear a portion of the costs of establishing and maintaining this charging infrastructure.

Unlike the above three countries, there are currently no incentive schemes to support EVSE deployment in Singapore.

4.1.7 Payment for the Use of EVSE

Although incentives from other governments around the world cover a part of the initial cost of installing EVSE, other operation costs need to be taken into consideration, such as electricity, maintenance and management costs. Thus, there is a need to collect charging fees during EVSE operation to recover these costs.

In the US for example, there are several EV charging networks – Blink, AeroVironment, ChargePoint, and SemaCharge for example, which provide their subscribers with EV charging facilities and services. The Blink charging system offers a free membership subscription and collects an access fee of US \$2/hour (HKD 15.5/hour) for guests and US \$1/hour (HKD 7.75) for members using their semi-quick EVSE. Another model used by AeroVironment sees unlimited monthly access for a fee of US \$19.99 (HKD 155) with an option of paying per session at a rate of US \$4/session (HKD 31/session) for semi-quick charging and US \$7/session (HKD 54/session) for DC quick charging.

Table 4-2 compares the countries under review with Hong Kong in terms of government incentives, funding, initiatives, and infrastructure. More details about the EVSE development status in Hong Kong are given in the next sub-section.

	Japan	Singapore	UK	US	Hong Kong
Government Incentives	Subsidise 50 percent of cost; subsidy increased to 67 percent if the plan of local gov't. or highway agencies is followed	--	Subsidise 75 percent of the cost, capped at £900	Tax credit of up to US \$1,000 for individuals and US\$30,000 for commercial buyers	Grant concessions on Gross Floor Areas (GFA) for "EV charging-enabled" car parks in new buildings
Government Funding	¥100.5 billion to expand charging infrastructure to ~12,000 charging points	--	£37 million of funding for charging infrastructure; another £32 million mainly for a DC quick charging network	\$230 million for the "EV Project", EVSE deployment is part of the project	--
Government initiatives	Collaboration with Toyota, Nissan, Honda and Mitsubishi announced, agreeing to support the goal of installing 4,000 DC quick EVSE and 8,000 semi-quick EVSE, and build a convenient and accessible charging network	Electric Vehicles (EVs) Test-Bed programme to examine issues relevant to policies regarding roll-out of EVs Awarding of "Green Mark" points by the Building and Construction Authority to buildings which allocate charging facilities	"Plugged-in Places" (PIP) fund to support EV charging infrastructure Require all publicly-accessible gov't-funded EVSE to be placed on a freely-available national dataset used by websites, apps and Sat-Nav developers to communicate EVSE locations to drivers	The "EV Project" collects and analyses data to characterise vehicle use and evaluate the effectiveness of charge infrastructure. Workplace Charging Challenge, aiming to achieve a tenfold increase in the number of US employers offering workplace charging	A pilot scheme to enable electric taxi suppliers to install quick chargers at car parks administered by the Transport Department Replace 100 standard EVSE with semi-quick EVSE
Government-built infrastructure	Fund 4,000 DC quick EVSE and 8,000 semi-quick EVSE	Install 68 standard EVSE and 3 DC quick EVSE in the EVs Test-Bed programme	Fund >5,500 charging points in "Plugged-in Places" programme	Fund 11,846 semi-quick and 87 DC quick EVSE in the "EV Project"	Install ~500 standard EVSE and 100 semi-quick EVSE at Government car parks

Table 4-2 Government support of EVs in various countries

4.2 A Review of EVSE in Hong Kong

4.2.1 Overview of EVSE in Hong Kong

The Government has worked closely with the private sector to build and expand the EVSE charging network. Currently, there are 1,004 public charging points²¹, approximately 50 percent of which are located in 18 public car parks managed by the Transport Department and Government Property Agency, with the remaining 50 percent installed for public use by the two power companies at different premises.

In 2013, there were only 32 semi-quick Level 2 charging points in Hong Kong. In 2014, this figure increased to 144. Ten DC quick charging EVSE have been set up in various districts in order to ensure that there is always one quick charger within 20 kilometres.

4.2.2 Government Policies

To encourage the installation of EVSE in new buildings, the Government provides concessions which will be granted, inter alia, on Gross Floor Areas (GFA) for “EV charging-enabled” car parks in new buildings. These parking spaces are required to be designed and built with the correct electrical wiring and sufficient power supply to facilitate the future installation of EVSE.

In its Policy Address 2014, the Government announced that it would launch a trial scheme to enable electric taxi suppliers to install quick chargers at car parks administered by the Transport Department

²¹ Due to the closing of Middle Road Car Park(中間道停車場), the number of public charging points decreases from 1,013 (Nov 2013) to 1,004 (Sep 2014)

to facilitate the operation of an electric vehicle fleet. The Policy Address also announced a plan to establish a total of 100 medium chargers (EVSE which supports both standard and semi-quick charging). One hundred standard chargers have been replaced by these new medium chargers. Starting from 1st August 2014, the new medium chargers for EVs became available for public use at 16 government car parks, and the number of semi-quick EVSE points increased from 32 to 144.

The Government is closely monitoring the growth in EVs numbers and is considering the need to further expand the charging network. The Government currently provides other support and information related to EVSE:

- i) A dedicated team with a hotline to help EV owners or buyers set up EVSE at strata-titled car parks;
- ii) Technical and arrangement guidelines provided by Environment Bureau, EMSD, and CLP respectively to prospective individual owners, tenants, and developers on how to set up EVSE;
- iii) A list of locations and types of all public-access EVSE in Hong Kong.

4.2.3 Utilisation of EVSE in Hong Kong and Issues Related to Level 1 Chargers

In November 2013, the Government released the estimated utilisation rates of public-access EVSE based on electricity consumption²². The average utilisation of each charging point was:

²² Government Press Release, LCQ14: Electric vehicles, 2013
<http://www.info.gov.hk/gia/general/201311/27/P201311270370.htm>

Standard charging points²³:

- 3.3 operations per month
(Government car parks)
- 4.1 operations per month
(other premises)

DC quick charging points:

- 61.0 operations per month

As can be seen, the use of DC quick charging EVSE is much more frequent.

As the standard Level 1 EVSE currently represents the majority of the three EVSE types in Hong Kong, HKPC conducted a site inspection in February 2014 to inspect the conditions of the standard Level 1 EVSE at Star Ferry Car Park in Central. Damage on socket outlets was discovered to appear after a certain length of service. Melted live-pin holes were also observed on several EVSE socket outlets.

The cause of this damage is due to the high level of heat generated and accumulated over a prolonged charging time and high charging current (e.g. 10 – 11 hours and 10A charging current for the Nissan Leaf). Long-term operation under such a profile can gradually weaken vital EVSE parts and components which were not originally

designed for charging EVs, eventually resulting in noticeable damage.

EV users can still plug their charging cables into to these melted or deformed sockets, leading to a consequently poor and unsecure connection between the plug and socket. This can result in overheating or even fire. Unlike the 13A socket, semi-quick and DC quick charging EVSE use standardised connectors that are solely dedicated to EV charging. Their designs ensure protective and durable usage which suits the prolonged charging time (overnight) and a high charging current.

While Level 1 chargers served their purpose for the earlier generations of EVs, which have a shorter range and thus shorter charging times, semi-quick and DC quick charging EVSE are becoming the prevailing trend, given the much longer driving range and higher current required for charging next-generation For example, the new Tesla Model S normally requires 3

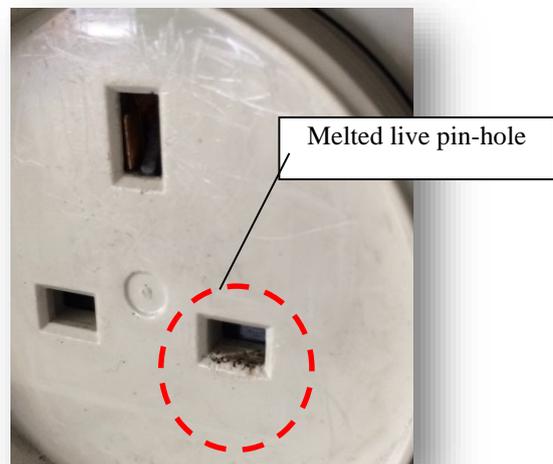


Figure 4-9 Melted 13A socket outlet for EV charging

²³ Calculation

Gov. car parks

500 charging points / 18 car parks = 28 charge points/car park

Per car park:

(93 charging operation/month) / (28 charging points)

∴ Each charging point: 3.3 charge operation/month

Other premises

500 charging points / (189-18) car parks = 2.9 charge points/car park

Per car park

(12 charging operation/month) / 2.9 charging points

∴ Each charging point: 4.1 charge operation/month

– 4 hours with using semi-quick EVSE to charge up from an empty battery. Using Level 1 EVSE, this would take nearly two days of charging, making Level 1 EVSE highly impractical.

4.2.4 Distribution of EVSE Around Hong Kong

Currently, there are 1,004 charging points in Hong Kong, distributed across over 220 sites. As of the end of August 2014, there were 782 EVs in use, making the EVSE to EV ratio about 1.3:1. Some local EV charging service providers suggested that the EVSE to EV ratio should be 7:1, as it is in the US. However, according to an analysis conducted by Better Place, there should be four public charging stations per electric vehicle (EV) in the initial stages, with this number dropping to as low as 2 to 1 as the EV population grows. New forecasts from Pike Research for the US market suggests that a ratio of 1.15 to 1.3 charging stations per EV is sufficient.

While Hong Kong is now still in the early stages of EV adoption, the EVSE to EV ratio should be on the high side. Eventually, when EVs become more prevalent and Government incentives are reduced, the number of charging stations will be driven by market forces. It will then become important to determine the revenue which operators can derive from EV charging stations – at a ratio of 4:1 there will be a lot more “idle time” at each station, compared to a ratio of 1.15:1.

In addition to the EVSE to EV ratio, the distance between charging points is another crucial consideration governing the usability of EVs in terms of their range. Most existing EVs have a range of only 160 km per charging cycle. If the air conditioning system is on the vehicles undergoes frequent start-stop cycles due to traffic conditions, the maximum range

can drop to as little as 100km. Normally, drivers wish to recharge their vehicles when the charge drops below 30 percent. Ideally, there should be at least one charging site within a 30km radius.

Given Hong Kong’s small geographic area, most places in the territory are within 30 km of an EVSE. However, most EVSE in Hong Kong is still Level 1 standard chargers with a slow charging time, meaning it is impractical to charge new-generation EVs.



Figure 4-10 Semi-quick EVSE in Hong Kong

Conversely, the 100 newly-installed Level 2 semi-quick and Level 3 DC quick chargers are mostly located in Kowloon and Hong Kong at either at Government car parks or Government offices. These locations are neither attractive nor convenient for private car users who would have to drive their cars – possibly out of their way – to such a car park to charge their EV.

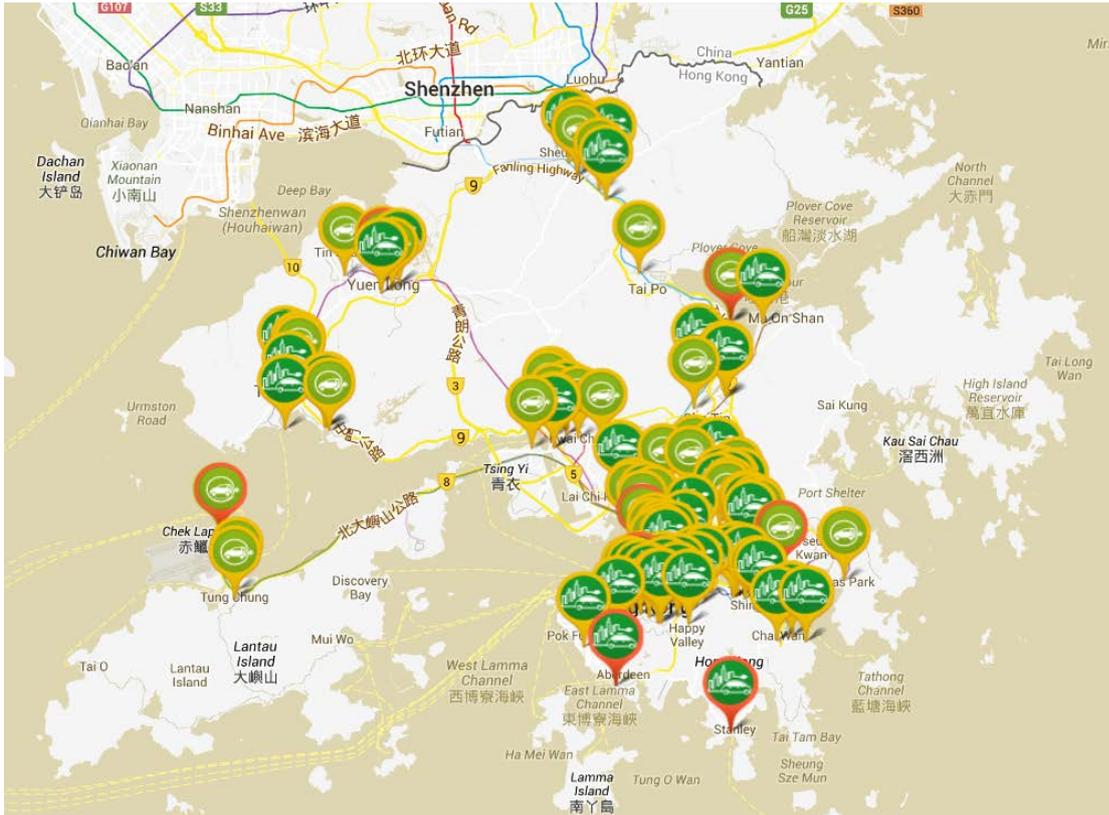


Figure 4-11 Overall EVSE distribution across Hong Kong

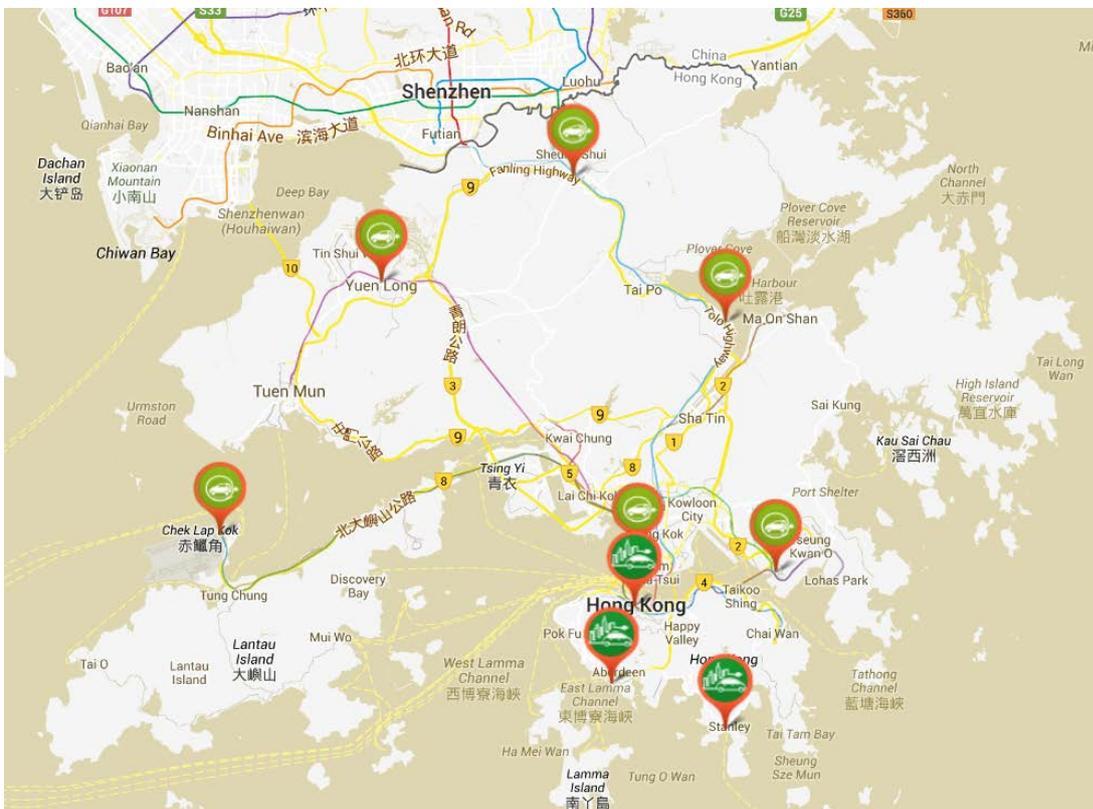


Figure 4-12 DC Quick Charger (Level 3) distribution across Hong Kong

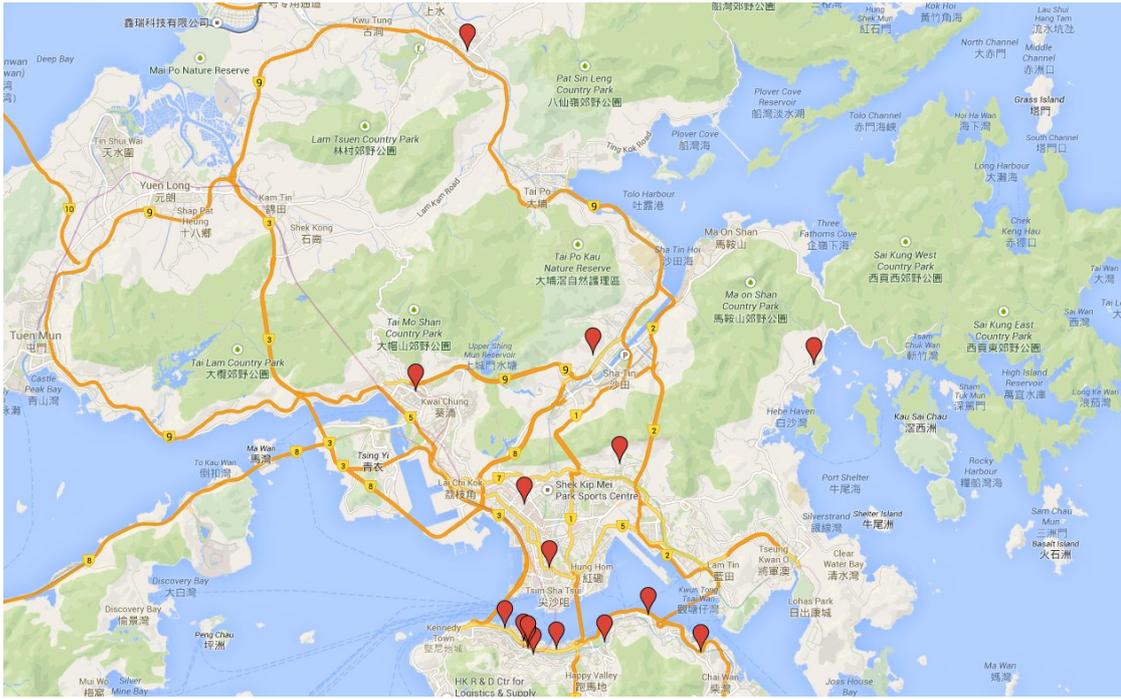


Figure 4-13 Distribution of 100 newly-installed semi-quick charging facilities (Level 2) across HK

4.3 HKPC's Views on EVSE in Hong Kong

4.3.1 Electricity Loading Limitations in Existing Car Parks

One concern about using EVs is the availability of higher-power EVSE to facilitate a shorter charging time. New-generation or “about-to-emerge” EV models allow a shorter charging time of between one and six hours, which is more feasible for commercial fleet operation than the 10 hours plus of charging time required by Level 1 EVSE.

EV charging equipment creates a much higher demand for electricity. Installing Level 2 EVSE and DC quick-charging equipment is easier and more cost effective in new buildings, as the corresponding infrastructure can be planned and accounted for during the building design and construction stages.

However, the existing electricity distribution systems in conventional car parks were not originally designed for the heavy power usage associated with charging EVs. Additionally, some car parks may not have the electric load capacity to support a larger-scale installation of higher-power EVSE. Furthermore, the costs associated with updating and retrofitting the power distribution system may be prohibitive.

4.3.2 Lack of Payment for Sustainable EV Charging Services

Apart from the initial investment in charging stations, substantial operational costs, including the costs of electricity and maintenance can also be a concern for some stakeholders. The electricity provider CLP states in its guidelines that car park owners or operators providing EV charging services must not collect fees from users

based on their electricity consumption. These limitations are a barrier for the car park owners and operators – they cannot formulate a sustainable business model to provide EV charging services, as there are no financial incentives involved in providing these services.

4.3.3 Parking Spaces Occupied by non-EVs

It is common sight in parking lots with EVSE: often the EV parking spaces are occupied by non-EVs. Due to the generally small number of EVs, parking spots with EVSE unoccupied most of the time. This creates a dilemma for car park operators, particularly during busy hours – opening these parking slots for non-EVs will further limit the charging opportunities of EVs, in turn giving potential EV buyers a further disincentive to switching to EVs.

4.3.4 Competing Global EVSE Standards

It is foreseeable that standard compatibility problems may worsen when more and more semi-quick and DC quick EVSE is deployed to shorten charging times. If a set of standards is not defined by the Hong Kong SAR Government as a part of the type approval process, then in spite of the expansion of the EV charging network, some EV owners and users may find that they cannot use many of these faster charging facilities due to the equipment being incompatible with their vehicles or cables.

4.4 Recommendations for EVSE Strategies

4.4.1 Recommendation 2

Create a common set of standards for all levels of Electric Vehicle Supply Equipment (EVSE) in Hong Kong

One key barrier to the wider adoption of EVs is the impression held by potential owners that there are many different charging standards for EVs available on the market. Many of these people would prefer to wait for a prevailing standard to emerge before making the decision to buy.

Defining an EVSE standard for Hong Kong will not only benefit potential EV owners, it will also benefit car dealers and EVSE suppliers, who will then have a common reference when importing or developing EVs and EVSE equipment. This will certainly act as a catalyst for the market to grow.

Indeed, for each level of EVSE in Hong Kong, a de facto standard has already emerged. For the Level 1 EVSE standard charger, BS1363 is the de facto standard the charging point uses to draw electricity from the main grid to an EV.

For the Level 2 semi-quick EVSE, The standard used by the Government when installing the 100 semi-quick EVSE points in 2014 – IEC 62196 type 2 – has become the de facto Level 2 standard in Hong Kong. As of July 2014, there were 137 IEC, 19 SAE

and several other standards installed in Hong Kong²⁴.

In terms of Level 3 quick chargers, as of July 2014, there were 10 DC-based Level 3 quick chargers, all of which were CHAdeMO standard. This is now the de facto standard for Level 3 quick chargers.

It is recommended that the Hong Kong Government standardise a common set of charging standards for EVSE in much the same way as they defined fuel supply standards for gasoline-powered cars or the BS1363 standard for electric plugs in households.

While the EV market development in Hong Kong has defined the de facto standard for all levels of EVSE in Hong Kong, it is still important that the Government

formally “rectify” the standards in its type approval process for new market entry EVs. This will go a long way towards alleviating market uncertainty concerning EV charging standards.

4.4.2 Recommendation 3

Migrate EVSE infrastructure to semi-quick and quick charging

All new-generation EVs have a larger battery capacity and a longer driving range. As such, Level 1 EVSE designed for earlier-generation EVs with a shorter range will eventually become obsolete. There are also safety hazards and user concerns associated with the prolonged use of the 13A socket of the BS1363 standard chargers, due to the longer charging times of new-generation EVs. As such, the notion of fading out the use of the 13A socket and providing the public with dedicated, better-protected and more

²⁴

http://www.epd.gov.hk/epd/english/environment/hk/air/prob_solutions/promotion_ev.html

secure charging facilities should be given serious consideration.

The expansion of the faster charging network will play a crucial role in the wider adoption of EVs. EV users in general start to get “nervous” if their EV’s remaining range is less than 30 km. A broader network of faster-charging EVSE will relieve this “range anxiety”, as well as being more feasible for commercial fleets to use with their EVs.

This study recommends that the Hong Kong SAR Government and EVSE operators consider installing a larger and broader network of semi-quick and DC quick charging EVSE by new installation or by migrating away from existing standard EVSE.

4.4.3 Recommendation 4

Set up a centralised database of EV charging points

Unlike traditional vehicles that can be refuelled at any petrol station, EVs are required to park at designated charging points for a certain period of time. These charging points are distributed across Hong Kong. An EVSE availability information system should be developed to provide EV drivers with up-to-date information on the locations and real-time availability of EVSE, traffic conditions and other variables. This information can be provided through the Internet or via a smartphone application.

A centralised database of EVSE (charging points) can be set up and maintained by the Government or by a neutral third party to provide up-to-date information on the locations and real-time availability of EVSE, traffic conditions, utilisation and other variables.

Information on the real-time availability of EVSE can also allow fleet managers and operators to find the nearest available charging points. A data-logging system will also be necessary to record the utilisation, usage profile and charging power of the charging points. This data can help the Government and electricity companies plan their expansion of the charging network.

4.4.4 Recommendation 5

Develop a viable business model for electricity supply for EVSE services

As mentioned, although the two power companies in Hong Kong do not have exclusive franchise agreements with the HKSAR Government, third parties cannot “re-sell” electricity supply by these companies without prior agreement. This means that third-party EVSE suppliers have very little financial incentive to set up privately-funded EVSE as they cannot charge EV users for their use of electricity.

It is therefore important that EVSE service providers develop a sustainable business model with property developers, property management companies and local power supply companies. If needed, the Government can play a role in facilitating these players to work together for the mutual benefit of all, through profit-sharing arrangements, intelligent payment systems capturing user information for charging purposes, and administrative fee arrangements for service providers and car park owners and operators.

4.4.5 Recommendation 6

Install power load management systems in existing car parks

Due to electric power loading limitations, it is challenging to install high power EVSE in existing car parks on a large scale. A load management system that can regulate the charging power of each EVSE is one immediate and cost effective solution to this challenge. For instance, if there are only a few EVs being charged and the demand for electric power is within the power capacity of a car park, these EVs can use the rated power of the semi-quick EVSE to charge their vehicles. However, when the number of EVs in the car park increases, some EVs may only use say 70 percent of the rated power of the semi-quick EVSE, which will keep the overall power demand in line with the capacity of the car park. Such a load management system can intelligently manage and distribute electricity to all EVSE chargers, such that all EVs can be charged within the limitations car park's power capacity.

Following overseas examples, the Hong Kong SAR Government can consider augmenting its support to both private and commercial EVSE deployment. This may come through an extension of the Pilot Green Transport Fund to cover the set up costs of EVSE.

4.4.6 Recommendation 7

Install more EVSE in private residential buildings and commercial sites with Government support

Historically, the Hong Kong SAR Government has been highly supportive of green transportation, by funding the purchase of electric buses and other vehicles through its Pilot Green Transport Fund. In terms of EVs, the Government has

initiated the installation of standard and semi-quick chargers at 100 charging points across Hong Kong. To take its support further, the Government should now consider creating incentives to encourage more private sector participation in setting up EVSE around the territory.

In other countries, government incentives are vital to attracting companies, car park owners and property developers to install EVSE, as it diffuses the economic risks for the other stakeholders. In Japan, higher incentives are given to those installing public access

EVSE which dovetail with the plans of the local government or highway agencies. Such an approach is prudent, as this can help the Government develop a more holistic plan for expanding the charging network.

Experiences in other countries show that payment for the use of EVSE facilities is eventually necessary, and comes with the growth of the EV market, even though all charging points were free to use during early stages of EV adoptions. It will be necessary for the Government to work with electricity companies in Hong Kong to resolve the issue of how to charge for the electricity used in EV charging and balance this with the interests of the electricity companies, service providers and of course, the users.

Currently, a key barrier preventing private car owners from switching to EVs is the lack of EVSE in private residential car parks. The cost of the equipment is high and the need to share these costs amongst property management companies and

owners make it difficult for the EVSE to be set up in residential car parks. Conversely, commercial fleet owners also feel that the cost of setting up electricity supply to a site where they plan to install charging points for their fleets is also prohibitive

Following the examples set in other countries, the Hong Kong SAR Government should consider augmenting its support for the deployment of both private and commercial EVSE. This can be achieved through the extension of the Pilot Green Transport Fund to cover the set up costs of the EVSE.

Chapter 5

Human Capital Development to Support EV Maintenance and Service



The aim of this chapter is to review the readiness and needs of local EV maintenance service providers in terms of supporting the adoption and proliferation of EVs in the future.

5.1 Overseas EV Maintenance and Service Training

United States

A number of institutions provide training in the field of EV maintenance and servicing: the EV Centres of America offer the *Certified Electric Vehicle Technician* (CEVT) certificate programme for electric vehicle production, repair and maintenance; while the National Alternative Fuels Training Consortium (NAFTC) offers a programme on Electric Drive Vehicle Career and Technical Education Training.

Regarding EV infrastructure servicing, the US Department of Energy promotes an EV Infrastructure Training Programme to certify electricians on the installation of a wide variety of EV infrastructure, including charging stations, distributed generation, facility-based electrical storage devices and other industry products.

United Kingdom

The Automotive Technician Accreditation (ATA) for Electric Vehicles has been established as an assessment mechanism to ensure that technicians have the skills and competence to maintain and repair EVs. The ATA measures an individual's performance against a set of key industry skills, as well as assessing their knowledge and ability and desire to work to a high professional standard.

5.2 EV Maintenance and Repair Services in Hong Kong

The first EV was licensed for operation on streets of Hong Kong in 2009. Given the relatively small number of EVs in use and the proprietary technology contained within them, the majority of EVs operating in Hong Kong are served by the workshops of the brand's dealers. As such, the service demand for private EV service workshops in Hong Kong is currently very small. An informative interview was conducted with Nissan LEAF EV dealers in February 2014. The dealers echoed the view that there was a limited service scope that a general vehicle workshop could provide for an EV.

Each EV works with a specific high-voltage energy block and every vehicle requires compatible equipment running unique software (e.g. the "Vehicle Control System software") for diagnosis and service. This equipment and the associated software is only available from the original equipment manufacturer (OEM).

These EV OEMs seldom sell the equipment, software and key components as "spares" to independent private vehicle workshops, due to the huge capital investment involved, and due to the fact that properly-trained technicians and engineers are essential to maintaining the highest levels of service quality. Moreover, it takes time to cultivate trust by an OEM to the dealer service teams.

Under the Scheme’s Registration Classifications, there are **four Services** for registration as follows:

Services	Coverage	Code
Mechanical	This covers the repairs and servicing of all chassis systems and components including vehicle engines, transmissions, brakes, steering, air conditioning system, lubrication and tyre work, but excluding fuel system of LPG vehicles. This also covers some basic electrical work.	M
Electrical	This covers the repairs and servicing of all electrical and electronic systems as well as air conditioning system within a vehicle. Examples are installation, servicing, repairs, diagnosis, testing and commissioning of electrical and electronic equipment and devices and their wirings.	E
Body	This covers body repair and painting. This also covers some simple electrical work which is limited to disconnection and reconnection of electrical equipment and devices.	B
Specific	This covers specific work related to vehicle maintenance but not fully fitting in the above M, E and B Services.	S

Figure 5-1 Voluntary Registration Scheme for Vehicle Mechanics
 Source: <http://www.emsd.gov.hk>

5.3 Current EV Maintenance and Repair Service Workforce

5.3.1 Sharing from the Nissan LEAF Maintenance Team Regarding the Current Training Model

The Hong Kong Nissan Leaf service team noted that before the launch of the Nissan Leaf EV, the dealer sent a small team of engineers to attend intensive training at Nissan in Japan. These engineers then became the trainers for local maintenance and repair service staff. They now receive regular updates on how to service new EV models from visiting engineers sent by the OEM. In-house engineers and technicians with suitable automotive service knowledge and experience are recruited and put through on-the-job training.

The Nissan team also recommended that the Hong Kong Electrical and Mechanical

Services Department (EMSD) consider adding the code “EV” to the existing classifications of the Voluntary Automotive Mechanics Registration Scheme²⁵. This addition will allow proper representation of the unique skill sets required for EV servicing and give the appropriate recognition to promote the professional identity of EV maintenance and repair personnel.

5.3.2 Training Needs to Support EV Repair and Maintenance Service Development

Repair and maintenance services for early adopters of EVs were provided by a limited number of service teams at local dealers. However, with EV adoption rates projected

²⁵ EMSD, *How to Apply Registered Vehicle Mechanic*, available at http://www.emsd.gov.hk/emsd/e_download/sgi/How_to_Apply_E.pdf

principles of automobiles, an MSc. in Automotive Engineering Design, and BSc. classes for those specialising in automotive design.

5.3.4 New Skills for Retrofitting and Conversion to Green Vehicles

To promote the conversion of conventional commercial vehicles to green vehicles, the Transport Department needs to consider putting in place a set of new type-approval requirements for commercial vehicles that are suitable for conversion. With such requirements in place, commercial operators can develop a suitable conversion-related business plan. New technologies, including pure battery EVs, hybrid EVs, Plug-in HVs and fuel cells can all be introduced.

The ability to retrofit and convert a conventional vehicle to a green vehicle will also raise the skill level of EV service personnel. Green vehicle retrofitting and conversion may also lead to new business opportunities for automotive test laboratories in terms of carrying out testing and type approval on converted EVs.

5.4 HKPC's Views and Recommendations

5.4.1 Recommendation 8

Update the Qualifications Framework for EV training

The Qualifications Framework (QF²⁷) for the automotive sector was launched in 2008. The QF aims to help the automotive industry set clear goals and direction for continuous learning to help practitioners acquire quality-assured qualifications in the automotive sector. Specifications of Competency Standards (SCS) were developed to identify the specific standards required for the workforce at different qualification levels.

A Credit Accumulation and Transfer (CAT) system is currently in place, which allows learners to systematically accumulate credits for training in various courses by converting accumulated credits into a recognised qualification.

With the rapid evolution in EV technology and the associated accessories, educational institutions and the automotive industry will need to assess the feasibility of continually updating the QF curriculum to cater for the future development of EV services. For example, additional sections related to electrical power and power electronics may be necessary.

5.4.2 Recommendation 9

Develop new training programmes for EV/EVSE maintenance and services

When the EV market eventually reaches maturity, there will be a rapidly-growing demand for properly-trained university graduates, engineers and technicians. The knowledge required by these EV practitioners will be distinctly different from the knowledge required to service conventional vehicles. Three major areas of expertise will be required in Electrified Transportation: EVs, EVSE, and charging infrastructure.

To prepare for the growing demand for EV-related services, the HKSAR Government should consider working with educational institutions, the automotive industry and other stakeholders so as to develop an appropriate education curriculum to support ET in Hong Kong.

Recommended Training Content

To fully support the industry, any training programme will require educational investment and participation by the government and various stakeholders, and ultimately the provision of career opportunities. Some of the required curriculums recommended

Training institutions such as the VTC and HKPC should consider developing new training courses, making reference to the Qualifications Framework programme, specifically for EV/EVSE maintenance and services on different models of EV.

include:

²⁷ Qualifications Framework, *List of SCSs*, available at <http://www.hkqf.gov.hk/guie/scs_list.asp>

A. ET supply chain

The ET supply chain consists of:

- i. Vehicle business planning, design and manufacturing;
- ii. Vehicle sales and financing;
- iii. Vehicle usage and emergency response;
- iv. Vehicle service and repair;
- v. Vehicle and component expiry.

B. Electric fuel charging-specific supply chain

The electric fuel charging-specific supply chain consists of:

- i. Charging station and electric vehicle supply equipment (EVSE) planning, design and manufacture;
- ii. EVSE sales and financing;
- iii. Charging station usage and charging facility installation;
- iv. EVSE service and repair;
- v. Charging and computer network operation;
- vi. EVSE decommissioning.

C. Smart grid/utility-specific supply chain

The smart-grid/utility-specific supply chain consists of:

- i. Grid planning, design and manufacture
 - Grid planning
 - Smart grid technology design and manufacture
- ii. Smart grid technology sales
- iii. Smart grid usage
 - Smart grid technology installation, repair and upgrades
 - Network operation

The Specification of Competency Standards (SCS) of the Automotive Industry in Hong Kong and workforce certification should be planned and endorsed within the Qualifications Framework²⁸.

In addition, the Government may consider working with tertiary institutions in the Mainland to roll out a mechanism for transferring credits and undergraduate internship programmes for local students. There are a number of well-established Mainland universities with good track records in automotive engineering research, which could offer valuable knowledge-transfer opportunities to local students.

²⁸ Qualifications Framework, *List of SCSs*, 2014, available at <http://www.hkqf.gov.hk/guie/scs_list.asp>

Chapter 6 Type Approval



RDW

(E4) e4

TYPE APPROVAL OF PASSENGER CARS

Category **M₁**

Topics with Base EC / ECE numbers

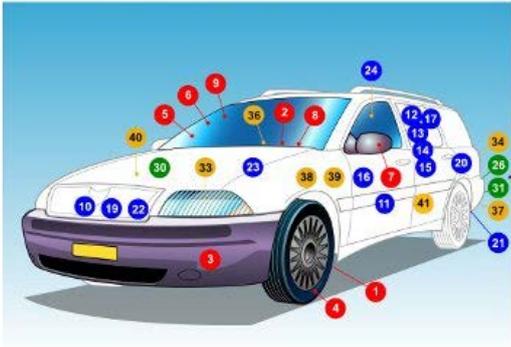
general topics: 18 25 27 28 29 32 35

ACTIVE SAFETY

1	Braking	71/320	R13H
			R90
2	Steering Equipm.	70/311	R79
3	Audible Warning	70/388	R28
4	Tyres	92/23	R30
5	Forward Vision	77/649	R125
6	Defrost / Demist	78/317	*
7	Rear View Dev.	2003/97	R46
8	Speedometers	75/443	R39
9	Wipers / Washers	78/318	*

PASSIVE SAFETY

10	Front Impact	96/79	R94
11	Side Impact	96/27	R95
12	Seat Belt Anchor	76/115	R14
13	Seat Belt Instal.	77/541	R16
14	Seat Strength	74/408	R17
15	Interior	74/60	R21
16	Latches-Hinges	70/387	R11
17	Head Restraints	78/932	R25
18	Ext. Projections	74/483	R26
19	Pedestrian Prot.	2003/102	*
20	Wheel guards	78/549	*



PASSIVE SAFETY (cont.)

21	Tank	70/221	R34
	Rear Underrun		R58
22	Front Protection	2005/66	*
23	Protect. Steering	74/297	R12
24	Safety Glazing	92/22	R43

ENVIRONMENT

25	Emissions	70/220	R83
	future requirement / recommended now	715/2007	R103
26	Sound Levels	70/157	R51
27	Recyclability	2005/64	*
28	CO ₂ / Fuel Cons.	80/1268	R101
29	EMC	72/245	R10
30	Aircondit. systems	2006/40	*
31	Diesel smoke	72/306	R24
32	Diesel Emissions	2005/55	R49

OTHER *: if applicable

33	Light Installation	76/756	R48
34	Registration plate	70/222	*
35	Masses-Dim.	92/21	*
36	ID of Controls	78/316	R121
37	Towing Device	77/389	*
38	Anti-theft	74/61	R116
39	Heating Systems	2001/56	R122
40	Engine Power	80/1269	R85
41	Plates (statutory)	76/114	*

For more information about all directives and regulations: visit www.rdw.nl and choose International visitor

Framework directive: 70/156, 2007/46 from 29 April 2009 onward

Source: <http://wiki.scribus.net>

6.1 Overview

All vehicles on the market in Hong Kong, including EVs, have to obtain a type approval from the Transport Department and the Customs and Excise Office. In the case of EVs, they must also obtain a type approval from the Environmental Protection Department. However, stakeholders including dealers, R&D institutes and local consultants are often unfamiliar with the EV type approval procedures and regulation guidelines, which leads to delays in obtaining approval from these departments.

In order to address the issues above, this report reviewed the type approval process in foreign countries and Hong Kong. The viewpoint of consultants from HKPC and their corresponding recommendations are also provided in this chapter.

6.2 Review of the Type Approval Requirement in Other Economies

6.2.1 Type Approval Requirements for EVs in the US

Type approvals are not required for motor vehicles and motor vehicle equipment sold in the United States. The National Highway Traffic Safety Administration (NHTSA) does not issue type approval certifications and does not certify any motor vehicles or motor vehicle equipment as complying with applicable Federal Motor Vehicle Safety Standards (FMVSS). Instead, in accordance with 49 U.S.C. 30115, NHTSA has in place a “self-certification” process, which imposes responsibility on the fabricating manufacturer to certify that

the vehicle or equipment item complies with the applicable FMVSS.

Self-certification reduces the cost and time associated with the lengthy, government-mandated testing that is required during the type approval process. Self-certification also reduces regulatory costs and facilitates international trade, as it allows fabricating manufacturers to quickly bring to market vehicles and equipment items that incorporate advancements in safety and technology.

The major FMVSS for electric vehicles are FMVSS305 Electric-Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection, 49 CFR Part 571.305. FMVSS No. 305 specifies performance requirements for the limitation of electrolyte spillage, retention of propulsion batteries and the electrical isolation of the chassis from the high-voltage system during a crash event. This standard applies to vehicles that use electricity as their propulsion power. Vehicles are tested to the requirements of FMVSS 305 in conjunction with testing to FMVSS Nos. 208, 214 (dynamic side impact requirements), and/or FMVSS 301 (frontal or rear impact requirements).

6.2.2 Type Approval Requirements for EVs in Europe

The EU legal framework for approval of motor vehicles is Directive 2007/46/EC. This is a mandatory application of the EC whole-vehicle type approval process across all vehicle categories, irrespective of their means of propulsion.

This type approval includes the electric safety of electric vehicles by the UNECE Regulation 100. The type approval of

electric vehicles in the EU includes other specific safety requirements. The EU has made amendments to UNECE Regulations 12 (protective steering), 94 (frontal impact) and 95 (side impact) concerning crash safety to cover risks specific to electric power-train vehicles. These amendments are mandatory for EU type approval. In addition, specific safety requirements for batteries have been adopted. These tests should be performed according to the 2nd amendment for Regulation 100: extension of scope to rechargeable energy storage systems with regard to their safety.

6.2.3 Type Approval Requirements for EVs in China

The type approval for EV in China includes the electrical safety of the vehicle. Safety of batteries, functional safety, protection against failure and protection against electric shock should be tested, according to Chinese national standards GB/T18384.1-2001, GB/T18384.2-2001 and GB/T18384.3-2001. A battery safety test should be conducted according to QC/T741-2006, QC/T742-2006 and QC/T743-2006. A vehicle crash test should also be performed in the same manner as other vehicles, although electrical system safety should be examined both before and after crash testing.

6.2.4 Type Approval Requirements for EVs in Other Countries

The standards for type approval in various economies are summarised in Table 6-1. The table illustrates that functional safety and occupant protection against electric shock and battery safety are mandatory test items

in the type approval process in these countries, however vehicle crash testing is not always mandatory.

Table 6-1 Type approval comparisons between Hong Kong and other economies

Regulations	Hong Kong	Japan	Korea	Taiwan	Mainland China	USA	EU
Functional safety and occupant protection against electric shock	<ul style="list-style-type: none"> ● UN/ECE R100(01 or 02 series) ● ISO 6469-1:2009, ISO 6469-2:2009, ISO 6469-3:2011 ● Japan Attachment 101 and TRIAS 67-2-2008, Japan Attachment 111 and TRIAS 67-3-2008 ● GB/T 18384-2001 ● FMVSS 305 ● QC/T 838-2010 	Japan Attachment 101 and TRIAS 67-2-2008 Japan Attachment 111 and TRIAS 67-3-2008	KMVSS Art.18-2 KMVSS Art.91	103.01.01:64 0	GB/T18384.1-2001 GB/T18384.2-2001 GB/T 18384.3-2001	FMVSS 305	UNECE Regulation 100
Battery safety	<ul style="list-style-type: none"> (i) Lithium Battery <ul style="list-style-type: none"> ● ISO12405 ● IEC 62660 (2010) ● SAE J2464 (2009) or SAE J2929-2011 ● UN/ECE R100 (02 series) ● UL1642 (2005) ● QC/T 743-2006 ● QC/T 741-2006 (ii) Non-lithium Battery <ul style="list-style-type: none"> ● QC/T 744-2006 ● IEC 61982 ● QC/T742-2006 		KMVSS Art.18-3	SAE J2464, UL2580 or related/equivalent	QC/T 743-2006 QC/T 742-2006 QC/T 741-2006		UNECE Regulation 100
Vehicle crash test	Not required for submission			103.01.01:45 1 103.01.01:46 1	Test same as a normal vehicle, but must check electrical system safety before and after crash testing		UNECE Regulations 12, 94 and 95

6.3 Type Approval Requirements for EVs in Hong Kong

6.3.1 The EV Type Approval Procedure

All EVs applying for vehicle approval in Hong Kong shall comply with the Road Traffic Ordinance (Cap. 374) and its subsidiary regulations. Figure 6-2 shows the detailed procedures required by vehicles when obtaining type approval.

In Hong Kong, the EV type approval procedure is quite comprehensive. It is governed by three departments: the Transport Department, the Customs and Excise Department and the Environmental Protection Department. Members of the public can look up the specific details of registration tax and registration fees on the official Customs and Excise Department website, which also lists the complete procedures

required for approvals, exemptions and licensing.

Basically, the guidelines for type approval include two major topics: functional safety and occupant protection against electric shock and battery safety. However, due to public concern about the safety of EVs – particularly during and after a crash – it is also worth considering vehicle crash safety in the type approval process. As shown in Table 6-1, The EU has already amended standards to include additional requirements for EV collision testing.

Meanwhile, there is no current requirement from Cap.374 to submit information regarding electric vehicle crash testing in Hong Kong.



Figure 6-1 Vehicle Examination Centre – Kowloon Bay

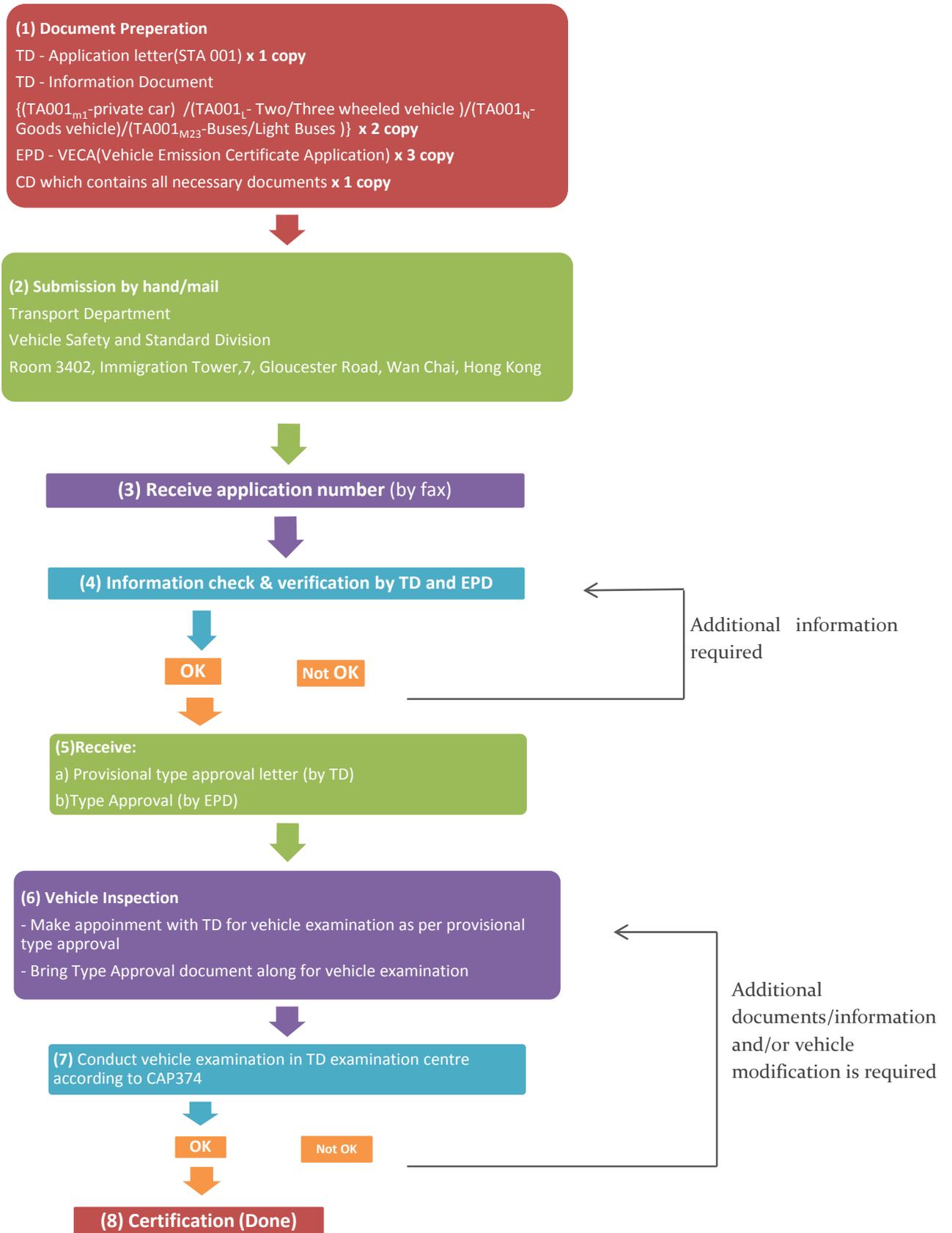


Figure 6-2 Flow chart show the type approval procedure for EVs



Figure 6-3 Vehicle Crash Test (Source: Cheshi, 2013)

Table 6-2 List of EVs available for sale in Hong Kong

Vehicle Classification	Model	Name of Retailer
Private Cars	Mitsubishi iMiEV	Universal Cars Limited
	Nissan LEAF	Honest Motors Limited
	Renault Fluence Z.E.	Wearnes Motors (HK) Ltd.
	BYD e6	BYD Auto Co., Ltd
	Tesla Model S 85kWh Performance	Tesla Motors HK Limited
	Tesla Model S 85kWh	Tesla Motors HK Limited
	Tesla Model S 60kWh	Tesla Motors HK Limited
	BMW i3 (01)	BMW Concessionaires (HK) Ltd.
	Renault Fluence Z.E.	Wearnes Motors (HK) Ltd.
	Tazzari “EM1”	Fortune Dragon Motors Ltd
Motorcycles	Brammo Enertia	JCAM
	Brammo Enertia Plus	JCAM
	Brammo Empulse	JCAM
	Brammo Empulse R	JCAM
	GMI Proton 750	GMI
	GMI Proton 850	GMI
	Zero S (ZF9)	Zero Motorcycles Hong Kong
	E-Max “120LD+”	JCAM
Light Goods Vehicles	Micro-vett electric Doblo (based on Fiat Doblo)	Fortune Dragon Motors Ltd
	Smith Edison (based on Ford Transit)	
	Renault Kangoo	Wearnes Motors (HK) Ltd.
	Mitsubishi Minicab iMiEV	Universal Cars Limited
Medium Goods Vehicles	Smith Newton	
Light buses	Smith Edison	
Buses	BYD K9	BYD Auto Co., Ltd
	HC-150-120	Great Dragon International Corp. Ltd.
	HC-150-105	
Taxis	BYD e6	BYD Auto Co., Ltd

6.4 HKPC's View and Recommendations

6.4.1 Close Monitoring of Technology Trends and Testing Requirements

Unlike traditional vehicles powered by fossil fuels, the technology used in EVs is developing and changing quickly. EV manufacturers in this rapidly-developing market are adopting newly-developed technology to make their products more innovative. These new technologies include, but are not limited to, wireless charging, better batteries, and lighter and more aerodynamic

vehicle body design.

For example, Toyota, Nissan and Volvo are currently researching wireless charging, IBM is working

on a promising battery technology called "lithium air", and BMW has started to use carbon fibre in their production cars in Germany.

With such rapid developments in EV-related technology, it is necessary for the Hong Kong SAR Government to periodically review and update the type approval standards.

6.4.2 Insufficient Coverage of Type Approval Standards

EVs are a growing market around the world. According to the information from the EPD website, the number of type-approved private car EV models in Hong Kong increased from 26 in June 2014 to 33 in August 2014. However, the seven "new" models were imported from the same countries. In order to broaden the import market of EVs and catch up with the rapid

global development of the EV industry, reference should be made to international safety standards, rather than the conventional standards of the importing nations.

6.4.3 Include Test Standards from More Countries for Type Approval

EV models available on the Hong Kong market are mostly imported from manufacturers in Japan, Europe and the US; and Hong Kong type approval regulation standards mainly draw on the standards used in these nations.

Reference should be made to other safety standards in use. For example, the test standards from Korea, a major emerging

automotive export player, are not currently used by the Transport Department for type approval. However, EVs made in Korea such as the KIA Soul EV and the Hyundai i10 EV are available in Hong Kong. Therefore, the test standards from Korea should also be adopted in the type approval process.

6.4.4 Recommendation 10

Update Type Approval Standards Once a Year

The "Type Approval Requirements for Electric Vehicles" document was first issued by the Transport Department in November 2010. At that time, there were only four standards incorporated in type approval. A second version of this document was issued in February 2014 and named "Vehicle Construction Approval Requirements for Electric Vehicles" and was applicable to pure electric vehicles and

The HKSAR Government should consider reviewing and updating the type approval requirements for the rapidly-developing EV market more regularly, once a year for example.

plug-in hybrid electric vehicles. It is worth noting the time difference between the two versions was four years.

Given the rapidly-developing industry, the technology involved in EVs is constantly changing. It may therefore be necessary to review and update type approval standards frequently. Compared to the more stable and traditional gasoline-powered car industry, where frequent type approval standards updates may not be necessary, a minimum update frequency of once a year is highly recommended for the EV market. The Hong Kong SAR Government should therefore consider reviewing and updating the type approval requirements for the EV market more regularly, such as once a year.

Chapter 7

Safe Disposal of EV Parts and Batteries



7.1 Overview of EV Recycling

Although the adoption of EVs is still in its infancy, the industry must start to prepare for the eventual disposal and recycling of EVs at the end of their service lives. Doing so properly will complete the “green mission” of EVs.

Unlike other rechargeable batteries, lithium ion (Li-ion) batteries contain no toxic metals and are generally categorised as non-hazardous waste when it comes to disposal.

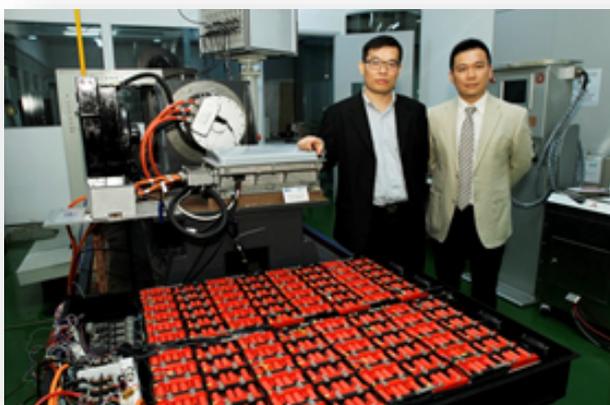
Li-ion batteries contain recyclable elements including iron, copper, nickel and cobalt. At present, not much has been invested in recycling Li-ion batteries due to the cost, complexity and low yield. The most

reduce net carbon emissions associated with electric vehicles.

As of 2012, there were already 28,000²⁹ new-energy cars or EVs operating in 25 Chinese cities, with 80 percent of them being buses. By 2016, a significant number of these EVs will have reached the end of their service lives. Analysts at Frost and Sullivan³⁰ predict that EV recycling, in particular battery recycling, will become a significant industry, worth possibly up to US \$2 billion.

7.1.1 Making the Best Use of Spent EV Batteries

In general, a loss of 20 percent³¹ of a battery’s rated capacity is the point at which most vehicle manufacturers deem a



expensive metal involved in the construction of these cells is cobalt. Lithium is less expensive than the other metals used.

Although lithium recycling has a low price incentive, the world’s lithium resources are limited. Once EVs become widely-adopted, the industry will need to begin to recycle lithium. Furthermore, the “second life” application of lithium is poised to further

battery “no longer viable for its intended purpose”. For earlier versions of EVs such as the Nissan LEAF, when the battery capacity

²⁹ China Daily, *China to extend subsidies for new energy cars*, 2013, available at <http://www.chinadaily.com.cn/business/motoring/2013-03/13/content_16304695.htm>

³⁰ Waste Management World, *ELECTRIC VEHICLE BATTERY RECYCLING TO HIT \$2 BILLION BY 2016*, 2011, available at <<http://www.waste-management-world.com/articles/2011/02/electric-vehicle-battery-recycling-to-hit-2-billion-by-2016.html>>

³¹ Galven, B. (2011) Time to fire on all cylinders, *Batteries International Issue 81* (pp.9-10), Don Cleary

falls below 80 percent of its initial value, it will only be able to achieve a range of 50 or 60 miles (80 or 100 km), but with the 85kWh Tesla Model S, degrading to 80 percent of its initial battery capacity will still give a range of 212 miles (340 km), as the larger batteries will still hold a lot of energy.

The Secondary Battery Use Committee of SAE is working to establish standards to quantify how much energy will be left in a battery, typically over a lifespan of 10 years. That means a large amount of energy could still remain in many battery packs deemed “spent”. There are then two options³² for dealing with these batteries: option one is to send the battery straight to a recycling facility. Option two is more interesting, and is where the so-called “second life” of EV batteries begins. Automakers, research labs, think tanks, universities and companies all over the world have dedicated significant resources to investigating secondary uses for spent EV batteries.

The most prominent of these potential “option two” applications are utilities services such as load levelling, stabilisation, and back-up power for emergencies; integration with renewable energy sources like solar or wind, where stored energy can smooth fluctuations in power output and make these sources more reliable and viable for utilities; and distributed applications such as stationary storage for residential solar panels.

7.1.2 EV Components as Compared to Regular Vehicles

The “green image” of electric vehicles is raising the recycling bar for automobiles in

³² Torque News, *You Only Live Once, unless you are an EV battery*, 2014, available at <<http://www.recycle-more.co.uk/banklocator/banklocator.aspx>>

general. According to CALSTART³³, an advanced transportation consortium in California, up to 70 percent of an EV’s component parts are different to those of a gasoline-powered vehicle. An EV has several unique components that need to be considered during their disposal. These unique components fall into two groups: the propulsion battery and electronics waste.

7.2 The Approach to Battery Recycling in Other Economies

7.2.1 Battery Recycling in the United States

As EV volumes remain low, automakers and battery suppliers are currently the key players in terms of battery system recycling. Table 7-1 outlines major OEM battery recycling practices in the US.

Since automakers generally take their social responsibilities seriously, both the battery recycling system and EV ecosystem have established without the need for government enforcement. In addition to these self-designed programmes, the US government has granted US\$9.5 million to the Toxco recycling plant for lithium battery recycling from electric and hybrid vehicles. Similarly, Germany has given US\$8.2 million to Chemetall for the recycling of electric vehicle batteries and the UK government has provided US\$0.8 million to Aexon for the same purpose.

7.2.2 Government Involvement in EV Battery Disposal

Early on, the **US government** recognised the importance of battery recycling and the ecological implications of widespread

³³ Advanced Vehicle Testing Activity, *How Do Gasoline & Electric Vehicles Compare?*, available at <<http://avt.inel.gov/pdf/fsev/compare.pdf>>

battery usage. Batteries that contain materials such as cadmium, lead and mercury that are not recycled are designated as Hazardous Waste by the US Environmental Protection Agency (EPA) under its Resource Conservation and Recovery Act (RCRA). Since 1995, the EPA has adopted the "Universal Waste Rule (UW)", an important regulatory measure designed in response to public demand. Under UW Regulations, batteries designated for recycling would be handled as Universal Waste (no longer Hazardous Waste), which diverts material away from landfills to the battery recycler. As a result of this regulation, there are now hundreds of commercial ³⁴ battery recyclers complying with US Federal and individual States regulations (such as Ohio³⁵).

In 2009, the **United Kingdom** adopted the "The Waste Batteries and Accumulators Regulations ³⁶". The Vehicle Certification Agency (VCA) is an Executive Agency of the Department for Transport and the national approval authority for new road vehicles, agricultural tractors and off-road vehicles. The VCA enforcement team has been providing guidance where necessary,

ensuring that producers register and submit annual records in a timely manner. The VCA also ensures that producers of industrial and automotive batteries provide information on the requirements to take back waste batteries from end users. Since January 2010, the disposal of waste industrial and automotive batteries in landfills or by incineration has been banned in the UK. Recycling is now the only option.

Despite being the world’s largest car manufacturer, **China** does not yet have a systematic recycling programme for vehicle batteries. Most batteries are collected by small, unlicensed vendors that collect valuable metal for sale and dump the other chemicals wherever they can. Automakers and suppliers are urging the Government to adopt western-style regulations and recycling systems and provide incentives to set up an ecosystem for new EV batteries. Currently, there are only a handful of commercial ³⁷ recycling companies that have begun recycling spent batteries, including Li-ion EV batteries.

Table 7-1: OEM battery recycling practices

OEM	Toyota	GM	Nissan	Tesla	Ford
Action taken	Offers \$200/pack, return batteries for recycling in Japan	Collect and resell batteries to wind/solar energy firms	Collect and resell to wind/solar energy firms	Collect and recycle 60% in the US, 100% in the EU	Supplier collects and ships batteries for recycling

³⁴ Metal Conversion Technologies, *Metal Conversion Technology News*, 2013, available at <<http://www.metalconversion.com/news.html>>

³⁵ Ohio Environment Protection Agency, *Battery Recyclers/Brokers & Disposal Facilities*, available at <<http://epawebapps.epa.state.oh.us/Recyclers/jsp/results.jsp?category=5>>

³⁶ VCA, *THE WASTE BATTERIES AND ACCUMULATORS REGULATIONS 2009*, 2009, available at <<http://www.dft.gov.uk/vca/enforcement/waste-batteries-industrial.asp>>

³⁷ Beijing Institute of Technology, *Review of Recycling Technologies for Spent Lithium-ion Batteries*, 2013, available at <<http://bestar.ibl.gov/us-china-workshop-2013/files/2013/04/Li-Li-BIT.pdf>>

7.3 The Battery Recycling Approach in Hong Kong

Due to the low number of electric vehicles on the road, there are currently no specific recycling programmes or regulations for electric vehicle disposal. In general, shops are required to collect old lead acid batteries and that is all. Similar to other recycling businesses, batteries are then shipped back to the Mainland for recycling.

7.3.1 Rechargeable Battery Recycling Programmes

Recognising the environmental benefits of battery recycling, in 2002, the EPD initiated a rechargeable battery recycling pilot programme. In partnership with green groups, the programme was formally launched in 2005. During its first year of operation, 13 tonnes of battery waste were collected, representing about five percent of the total rechargeable battery waste, a respectable result given that other countries only achieve a two to three percent recovery rate. However, the programme focuses on small-size battery cells instead of large-size EV traction batteries. A EV battery recycling and replacement programme has been proposed and implemented by local EV dealers and OEMs.

The Government should provide support and incentive to the EV recycling industry in the initial stage of EV adoption as a triggering point for the start of EV part and battery recycling industry in Hong Kong.

7.4 HKPC's Views and Recommendations

Given the developments in the recycling industry as indicated above, the Government should set out proper

regulations and priorities regarding battery recycling, which will require the OEMs to take EV batteries back at the end of their lifespan.

The Government should also look to the success of the rechargeable battery recycling programme and extend its ideas to vehicle battery recycling. Promoting awareness and public participation are highly effective ways of developing systematic requirements for recycling projects.

To accelerate the healthy development of new green vehicles, this study suggests that the Government and industry consider taking the following action:

- (A) Partner with dealers and vehicle OEMs to set up a recycling programme for EV battery collection at the end of the battery life. Dealers will then be obliged take back and recycle spent batteries. Other battery recyclers can work with the dealers to ensure these batteries are recycled or properly disposed of.
- (B) Set up a disposal programme and management system that allows waste batteries and harmful substances to be tracked at the end of their service lives. This information should be stored in a centralised database until the batteries are disposed of.
- (C) Manage used battery packs properly to create a "second life", enabling batteries to be fully utilised before sending them to a recycling facility.

(D) Cooperate with recycling facilities outside Hong Kong to properly dispose of batteries when such facilities are not available in Hong Kong. This may involve extra costs, which may in turn require Government subsidies.

(E) Impose “recycling deposits” of around HKD 2,000 to ensure that end users have an incentive to return spent batteries

7.4.1 Recommendation 11

Provide incentives to the battery recycling industry

As EVs are based on new technology and the adoption level is still low, there is little incentive for any practitioners in the recycling

industry to consider EV and EV battery recycling at this time. However, when EVs become more prevalent, there will be a strong need to dispose of and recycle certain parts of EVs which contain hazardous materials.

In order to kick-start this important industry, the Government should consider providing support and incentives to the recycling industry in the initial stages of EV adoption to trigger the start of the EV parts and battery recycling industry in Hong Kong.

The Government can consider, as a part of the type approval requirements, requiring OEMs to have a comprehensive tracking system which monitors the EV batteries in their cars from when the EV batteries are installed in the EV to the time when the EV batteries are finally disposed of.

7.4.2 Recommendation 12

Demand battery disposal plans and monitoring reports from OEMs

This study found that many neighbouring economies placed demands on carmakers and importers to take a stronger role in the disposal of EV batteries. In the same way, Hong Kong can benchmark the experiences and regulations of our neighbours when addressing concerns on the safe disposal of EV batteries. To this end, the Government has already earmarked “rechargeable batteries” in the Policy Framework of the “Producer Responsibility Scheme” (PRS) as one of the six types of products to be included. This scheme requires manufacturers, importers, wholesalers, retailers and consumers to be responsible for what they have produced and consumed. The PRS can also provide a stable stream of materials allowing the development and sustainment of the local recycling

industry.

The Government can also consider, as a part of the type approval requirements, requiring OEMs to have in place a comprehensive tracking system which monitors EV batteries in their cars from when the EV batteries are installed in the EV to the time when the EV batteries are finally disposed of.

The Government may also make it mandatory for all EV suppliers and dealers in Hong Kong to provide a battery disposal and monitoring plan during the type approval application process. OEMs should be made

responsible for the recording, tracking, collecting and ultimately the recycling of the EV batteries in their cars.

7.4.3 Recommendation 13

Explore ways to extract valuable materials from waste EV batteries

While an EV battery will often reach the end of its service life after four or five years of use, the battery can still be used in other applications, as it will still retain up to 70 percent of its charging capacity. In addition, there are many different types of minerals and metals in an EV battery which can be recycled and used for other applications.

This study recommends that the Hong Kong SAR Government provide R&D funding to carry out research into exploring ways to safely extract valuable materials from end-of-life EV batteries including cobalt, aluminium, nickel, copper, lithium and others.

The study further recommends that the recycling service providers explore other applications to create a “second life” for EV batteries. One example is for these waste batteries to become batteries for storing electricity generated from wind farms and solar panels.

Chapter 8 Conclusions



Government Must Play a Leading Role

From the desktop research conducted on EV adoption around the world, it is evident that the governments of various countries and cities play a leading role in the promotion of EV adoption. This study also found that some governments put in place a holistic plan and adoption target for EVs, allowing programmes to be developed and rolled out in a coordinated manner.

The Adoption of Private EVs and Commercial Fleet EVs Should be Promoted Differently

The study found that most countries support private EVs through the set up of various types of EV charging points, through government subsidies, incentive programmes and the direct installation of EVSE and infrastructure. The promotion of private EVs is generally left to EV vendors themselves. In terms of commercial fleet EVs, many governments put in place special trial or pilot programmes such as e-taxis or e-delivery vans using direct government subsidies. Commercial fleets appear to be “low hanging fruit” through which the Hong Kong Government can begin to reduce air pollution problems, since roadside air pollution in Hong Kong is mostly caused by commercial fleets.

One of the focuses of this study was on the electrification of commercial fleets, since while only 20 percent of Hong Kong vehicles are in a commercial fleet, 80 percent of the roadside air pollution is generated by these vehicles. Interviews were conducted with major stakeholders in several commercial fleets, including fleet operators, property developers and management offices to collect their views and concerns regarding EV adoption.

Key Concerns from Commercial Stakeholders

1. **Long charging cycle** – stakeholders expressed concerns on the long charging cycle of EVs. They viewed that the many hours of charging time required for EVs would lessen the duty time for their commercial vehicles, thus increasing their costs. They were also concerned about the installation costs of EV charging stations, particularly the set up of high-voltage power supply infrastructure.
2. **Cost concerns** – Apart from the set up costs of the EV charging infrastructure, the stakeholders were also concerned about the operating costs of repair and maintenance. As EVs are regarded as new technology, the stakeholders were uncertain about the reliability of EVs and the costs involved in repair and maintenance. Unlike traditional vehicles, where generic repair shops are widely available, EVs currently have to be maintained by authorised dealers.
3. **Reliability of EVs** – As commercial fleet operators require their fleets to have a high level of availability, and with EVs using new technology, the stakeholders felt this inherent reliability uncertainty would affect their revenue. In addition, they were concerned about the lifespan of EVs as opposed to traditional vehicles.
4. **EV batteries** – Unlike traditional vehicles, the batteries in EVs have a finite lifespan of typically four or five years. Stakeholders expressed their concerns about how EV batteries will be disposed of, and the cost implications of this. They were also concerned about the safety of old batteries running towards the end of their operational lives.

EV Adoption: the Five Key Areas

Based on the global survey and interviews with local stakeholders, this study has identified five key areas in terms of the EV industry infrastructure and ecosystem which will require special attention and support to reduce the barriers to EV adoption moving forward. The five areas are:

- a) Overall Government role in promoting EV adoption;
- b) The set up of EV charging infrastructure;
- c) Human capital development in EV maintenance and support;
- d) Update of the type approval regime;
- e) The disposal of hazardous materials in EVs, particularly batteries.

This study comprehensively looked at each of these five areas, examining them from the angle of overseas practices and initiatives, and from the local perspective. For each of the four key areas, the study provided the HKPC's views as well as a set of recommendations for key stakeholders including the HKSAR Government, service providers, property management companies and property owners, as well as training institutions.

The Way Forward

This study has sought to identify additional strategic directions and initiatives which have the potential to further promote EV adoption in Hong Kong. Gainful fulfilment of the HKPC's recommendations within the Government's policy infrastructure is outside the scope of this study, as the execution of these recommendations would necessarily demand further in-depth study and consultation with regard to strategic priorities and resource planning.